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Original Article

Effect of Core Strength in Physical Performance of Young Soccer Players

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ABSTRACT

The strength prevention training has beneficial effects for young soccer. Our aim is to identify effects of balance and stabilization training on physical fitness performance of young soccer players. 40 players who train regularly in soccer were divided into two groups (Prevention and control groups). The Prevention group performed a program of eight weeks of core postural stability training and muscle strengthening three times a week whereas the control group trains as usual. Sit-ups, push-ups, squat-jump five-jump tests, squat on one leg and jump test landing and 30 m speed were tested before and after the 8-weeks and strength training programme. **S**ignificant improvement was observed in the prevention group in sit-ups (21.26 ± 1.96 *vs* 25.57±2.06), push-ups (19.73 ± 2.25 *vs* 23.31± 2.26), squat-jump test landing (5.10± 2.45 *vs* 8.67±1.74) and in jump performance (5JT and SJ) ($p \leq 0.05$). A special attention for the importance of the integration of stability, proprioception and balance training programs that is essential to optimize physical performance.

Keywords: Postural control, Youth, Soccer, fitness, Fitness

INTRODUCTION

Core stability training has become popular and is frequently recommended as a training method in rehabilitation, injury prevention and performance enhancement (Hubscher et al., 2010; Sadoghi et al., 2012). Within many sports, especially the team-contact sports, the need to develop the players' capacity in order to maintain possession of the ball, in soccer for example, are fundamental to the outcome of the game. The strength of the core also plays an important role in determining a soccer player's quickness, not only in terms of sprint speed but also in the ability to change directions and is vital in winning the ball when shoulder to shoulder with another player (Cholewicki and VanVliet. 2002; Lehman, 2006). The core, although commonly thought to only include the abdominal muscles, also includes the muscles in the back and the upper hip.

In reference to dynamic movement patterns core stability is defined as being "the ability to control the position and motion of the core over the pelvis to allow optimum production, transfer, and control of force and motion to the terminal segment (Kibler, Press, and Sciascia, 2006), in integrated athletic activities (Borghuis et al. 2011). However, core stability exercises have become very popular and these exercises are used by fitness instructors in fitness centers or strength and conditioning specialists in fitness clubs beside athletes in professional and amateur sport teams (Saeterbakken et al., 2011). Core Stability (CS) is essential for stabilizing the trunk in order to (a) provide support for movement patterns, (b) transfer forces and (c) reduce the energy leaking among limbs. In sports performances, core strength is also very important to improve body

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balance and postural control in movements such as landing and contact (Hsu et al., 2018).

Core muscles including the transverse abdominis, multifidus, diaphragm, and pelvic floor muscles are thought to contribute stability of the spine (Malátová et al. 2013). Reports have shown that transverse abdominis contracts first to contribute to stiffness as a feedforward function during upper limb activities and standing tasks involving sudden perturbation (Allison et al 2008). Indeed, core stability training is seen as being pivotal for efficient biomechanical function necessary to maximize force generation and minimize joint loads in all types of activities ranging from running to throwing and subsequently decrease the incidence of injury (Hibbs et al. 2008).

Kibler (2006) has argued that "since the core is central to almost all kinetic chains of sports activities, control of core strength, balance and motion will maximize all kinetic chains of upper body and lower extremity function. Leetun et al., (2004) suggest that motor control and muscular capacity create core stability. Others have referred to core stability as being comprised of components such as core strength, endurance, power, balance, as well as the coordination of the spine, abdominal, and hip musculatures (Liemohn et al., 2005; Cowley & Swensen, 2008).

Bliss and Teeple (2005) identified CS as the center piece of training programs, because of its' powerhouse and linking functions. Reed et al. (2012) highlighted that although core stability training (CST) implications resulted with improvements in aspects of general strength such as vertical jump and maximum squat load, generally out comes of various CST implications showed mixed results.

Soccer is one of the sports that CS plays crucial role as the environment during the game is ever-shifting and requires sudden postural responses and balance maintenance (Borghuis et al., 2011; Cholewicki et al., 2000). Reilly, (2007) stated that agility and sprint are the most important criteria for developmental level soccer players. This has led to an emphasis of using core stabilization to improve control of core musculo-structure, which has role on rapid movement changes. Dawes and Roozen (2012) highlighted that level of control and strength of the core muscles will result with better movement patterns and performance, due to high neuromuscular control causing transfer of forces. Core stability is directly related to balance performance, as improving the control of core region of the body resulted with better dynamic balance in young athlete group (Sandrey and Mitzel, 2013).

Exercise methods for improving athletic performance or developing children´s various abilities are highly controversial issues in the current literature. Many investigators have examined the effectiveness of core training programs on athletic performance levels (Durall et al., 2009; Sato and Mokha, 2009, Afyon et al., 2017). For improving functional compounds of performance such as balance, researchers have started to conduct studies on different exercise methods such as CS and balance trainings (Bliss and Teeple, 2005; Boccolini et al., 2013).

Core stability training is heterogeneous term; literature indicates studies represent a diverse range of movements, intervention styles and target population. Most of the CS studies conducted on athletic performance are focused on mature athletes. Although the importance of CS in athletic performance is being increasingly recognized, there are inconsistencies about optimal exercise protocols and methodologies through which CS have effective impact on junior athletes. Some of the studies demonstrated positive significant effects of CS on strength (Myer et al., 2008; Szymanki et al., 2010; Trzaskoma et al., 2010), vertical jump performance (Myer et al.,2006), static balance performance (Filipa et al., 2010) among various populations. On the other hand, different studies indicated no effect of CS on various outcomes such as CS (Lust et al., 2009), flexor endurance test (Tse et al., 2005), dynamic balance measured by single leg hop (Aggarwal et al., 2010). Thus, the response to the applied combination of exercise type, intensity could be different, causing controversial issues related to applications. As previously emphasized by Cosio-Lima et al. (2003) the mechanism of CS is related to mechanism of balance and postural stability.

As a result, the aim of this study was to evaluate the effects of an 8-week core strength Program on balance tasks with support leg stance conditions and on speed and strength physical performance among young soccer players (13-15year). We hypothesized that the training group significantly improved their core endurance times on tests and that the 8 to week training protocol was effective enough to stimulate increases in trunk muscular capacity and performance.

METHODOLOGICAL PROCEDURE

Participants

The sample consisted of young male athletes ranging in age from 13 to 14 years, who are part of a player development program of regional level soccer's players, member of sector-based training centers, selected and integrated towards the age of 13 years for a training formation which will last three years. All boys participating in this program are selected based on their height and their ability to play soccer. During the selection process, hundreds of boys from different parts of Tunisia, especially, are evaluated and selected by coaches of the soccer club.

The boys selected during this phase present the adequate biological characteristics to play in all soccer positions: goalkeeper, defender, midfielder, or forward. After the selection process, the boys were enrolled in a training program developed by the soccer centre.

Fourteen young soccer players agreed to participate in the study. These players practice soccer 9 to 10 months a year, at a rate of 4 to 5 sessions a week with one competitive game per week, in addition to their school physical education. These players were divided on a randomized order on two groups: Trained Group (TG, n=20) and Control Group (CG, n=20). TG participated to a core strength-training program during 8 weeks. The players from TG participated 2 to 3 sessions per week in a core training program aiming at enhance physical performance. The duration of a core strength training (CST) session was 30 min.

Players were informed that they would receive a program of warm up exercises used to improve balance and stabilization strength and enhance performance.

Experimental Procedure

The soccer players and control subjects were evaluated at two different time points. The measurements were made each time over a day period. On the testing day, after a standardized warm-up of 15 minutes, consisting of low-intensity running, followed by a series of exercises (high knee lift, butt kicks, straight line skipping) and then short accelerations, subjects performed the running speed tests, agility test and vertical jumping tests.

Puberty stage assessment

The puberty stage was the indicator of biological maturity status. It was determined and recorded by a paediatrician experienced in the assessment of secondary sex characteristics according to the method of Tanner (Tanner, 1975). Children at pubertal development stages 1-5 were evaluated. According to their pubescent status, the young soccer players and the control group belonged to Tanner stage (2-3).

Anthropometry characteristics

Each participant came to the medical centre of the training centre for a medical examination and anthropometric measurements performed by a paediatrician at each period (T0 and T1). Body height and body mass were measured with standard techniques to the nearest 0.1 cm and 0.1 kg, respectively for each subject. To estimate the adiposity, skin-fold thickness were measured at four sites on the left-side of the body (triceps, biceps, subscapular and suprailiac) using a Harpenden skin-fold calliper (British Indicators Ltd., Luton) for calculation of percent body fat according to the equations described by Durnin and Rahaman (1967).

Physical Fitness Characteristics

Physical fitness characteristics were determined using the following tests: Sit-ups, Push-ups, test stabilization jump and Running speed test (Sprint Test 30m), Squat and Five jump test (FJT), were used to assess the participants' physical performance.

Sit-up Test

The participant sat on a rubber mat, with the knees in 90° of flexion and the feet placed 10 cm apart on the floor. The hands were clasped behind the neck and the elbows placed against the knees. The test examiner knelt in front of the participant pushing the participant's feet lightly against the mat. The participants wore shoes during the test. The participant lowered her upper body until the scapula came in contact with the mat. The participant's head was not permitted to touch the mat. The participant then reversed the motion by curling back up to the starting position. To investigate power is recorded for 30-second timed sit-ups (Cowley and Swensen, 2008).

Push-ups

The participant was in a prone position on his toes and hands. The hands were placed shoulder width apart with the fingers pointing forward. The elbows were held in full extension and the feet were placed 10 cm apart. The push-ups were performed on a rubber mat and the participants wore shoes during the test. In a continuous motion, the torso was lowered by bending the elbow joints to 90° of flexion. Keeping the midsection tight and the head held in a neutral position, the participant then pressed him/herself back up to full elbow extension. To investigate powerfor 30-second timed push-ups.

Single-leg Jump-landing Stabilization Times

Subjects were assessed for maximum 2-footed vertical jump. Subjects were instructed to use a jumping technique that allowed them to jump as high as possible (Brown et al., 2004; Wikstrom et al., 2005). They were allowed to swing their arms as they jumped but were then required to hold their reaching arm at 180° of shoulder flexion. Subjects were instructed to "stick" the landing on their test leg, stabilize as quickly as possible and remain as motionless as possible in a single-leg stance for 10 seconds. We did not control for arm position, trunk flexion, or lower extremity flexion during foot contact or stance. Three practice trials were performed.

Assessment of 30 m Sprint Times

Linear sprint speed was evaluated over 30 m. Infrared timing gates (Cell Kit Speed Brower, USA) were positioned at the start line (0m) and at 30m at a height of approximately 0.5 m off the ground. Participants commenced the test from a standing start at a distance of 0.3 m behind the first timing gate before initiating the test following a countdown from the lead investigator. Players were instructed to run at maximal speed throughout the full duration of the sprint test. To prevent a reduction in sprint speed on approach to the 30 m gate, a member of the coaching staff who stood on a marker 2 m beyond the final timing gate provided verbal encouragement throughout each attempt. Players were instructed to maintain maximal speed until passing the marker on which the coach stood. Timing started and finished when the lasers of the first (0 m) and last (30 m) gates were broken, respectively. Athletes performed three repetitions with the best (fastest) times used for statistical analysis. A minimum of 4 min of recovery were provided between repetitions

Assessment of performance of Jumping

Each subject performed three kinds of maximal jump, 1) the squat-jump (SJ), starting with knees bent at 90° and without previous counter movement. The ground reaction force generated during these vertical jump were estimated with an ergo jump (Opto Jump Microgate - ITALY). In addition, the subjects performed a five-jump-test (5J); each subject performed 3 jumps interspersed with 1-minute rest between each jump, and the best was used for analysis.

Training Program

Exercise program lasted for 8-weeks, 3 days a week and 30 minutes a day. Totally 24 sessions were completed. Core stability training Protocol was progressive as was suggested previously by Bliss and Teeple (2005) from static movements to dynamic movements and finally combination of these (Table I).

Statistical Treatment

To analyze the results of tests, we used the SPSS 13.0. The statistical tools used are: average. Standard deviation (S.D.) and analysis of variance. The test applies when measuring one or more categorical explanatory variables (called factors of variability then. their different methods are sometimes called "levels") that influence the distribution of a variable continues to explain. There is talk of a factor analysis when the analysis focuses on a model described by a variability factor, two-factor analysis or multivariate analysis.

RESULTS

Anthropometric and Physiological Characteristics

The baseline measures were not significantly different between TG and CG (Table 2). Height and weight increased during the 8-week training period in both groups with no difference between the two groups. No significant changes were observed for Lower Limb Length (LLL) for neither group.

During pre-test, no difference was observed. However, after two months of work. The improvement obtained is significant for the prevention-Group compared to the control group in push-ups test. (Figure 1), sit-ups (Figure 2) and single-leg jump-landing stabilization times test (Figure 3) ($p \leq 0.05$).

However the test speed of 30 meters, five jump test, squat jump index averages values obtained from both groups were statistically comparable in the test and retest (Table 2).

Table 1: Training program schedule

Overall stability of anterior and posterior trunk channels	Decubitus ventral: – 20 to 25 seconds of isometric contraction. – 6 to 8 repetitions. – 2 to 3 sets. – The recovery time between repetitions is equal to working time. – The recovery time between sets was 2 minutes. – To avoid any muscular compensation and deteriorating posture. it is preferable to reduce working time and increase the number of repetitions	Decubitus rib: – 2 0 to 40 seconds of isometric contraction. – 3-4 repetitions – 2 to 3 sets. – Recovery time between repetitions of contraction. – Recovery between sets = 2 minutes.	• Supine: – 10 to 20 seconds of isometric contraction. – 10 to 15 repetitions. – 2 to 3 sets. – Recovery time between repetitions = effort. – Recovery between sets = 2 minutes.
Shoulder girdle and Lower Limb	• Number of repeat 20 or more series 2-5 with 2 minutes recovery. • The exercises performed in a dynamic but slowly. • No normal breathing without blocking with postural correction.		

Table 2: Anthropometric and physiological characteristics of Training Group (TG) and Control Group (CG) determined at the beginning of experimentation (T0) and at the end of the experimentation (T1)

	Training Group		Control Group	
	T0	T1	T0	T1
Height (cm)	167.7±6.5	168.3±6.1	168.6±5.7	169.7±58
Weight (kg)	52.9±6.2	54.0±6.1	52.6±8.1	54.2±7.5
LLL (cm)	86.9±2.1	87.1±4.4	88.8±4.3	89.6±3.5

Table 3: Physical performances of Training Group (TG) and Control Group (CG) determined at the beginning of experimentation (T0) and at the end of the experimentation (T1).

	Trained Group		Control Group	
	T0	T1	T0	T1
Sprint 30 m (s)	4.92±0.25	4.76±0.21	4.95±1.06	4.81±0.21
5JT (m)	10.2±0.5	12.2±0.7α£	10.5±0.6	11.9±0.5α
SJ (m)	27.8±6.5	32.9±5.6α£	29.2±3.3	31.9±3.2α

Data are means and SD, 5JT: 5 Jump Test; SJ: Squat Jump; £: Significant differences between TG and CG, £ p<0.05,; α: Significant differences between T0 and T1, α p<0.05

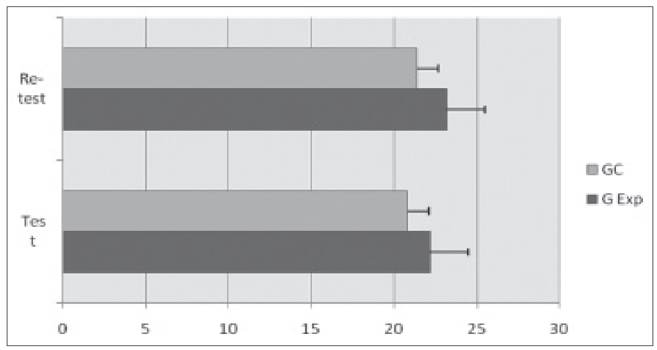

Figure 1: Retest –test Sit up Test (EXP G: Experimental group, CG: Control Group (*p= 0.01)

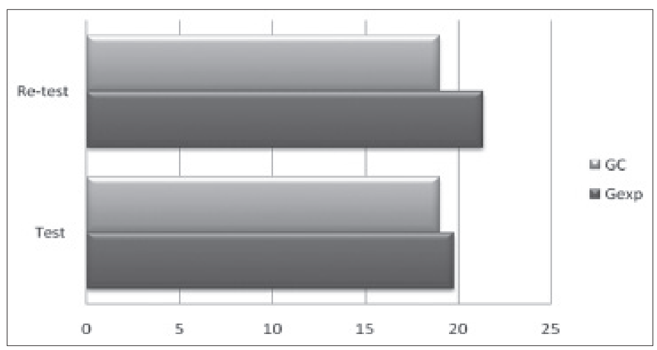

Figure 2: Retest –test Push up Test (ExpG: Experimental Group, CG: Control Group (*p= 0.02)

Physical performances

Sprint runs

There were no significant changes in 30m- running times for the two groups between T0 and T1. Hence, TG revealed decrease in 30m- sprint running than CG compared after training program but statisticaly no signifcant.

Jumping performances

As shown in table 2, significant increases were observed in 5JT and SJ throughout the experimental period both for TG and CG. In addition, the improvement amount was significantly greater (p<0.05) in 5JT in TG compared to CG.

DISCUSSION

The objective of our study is to detect the effects of 8 weeks core training programs on athletic performance on physical fitness performance of young soccer players (13-15year). The result from the current study shows improvements in push-ups, sit-ups, single-leg jump-landing stabilization times and jump performance (5JT and SJ).

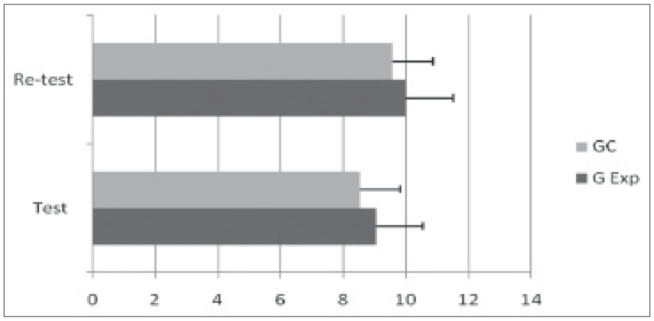

Figure 3: Retest –test Stabilization Jump Landing Test (TG: Trained group, CG: Control) (*p≤ 0.05

One of the most common field tests used to assess the core musculature, specifically the rectus abdominis, is the sit-up. The sit-up has been incorporated into many physical training programs because of the ability of this exercise to effectively activate the abdominal and hip flexor musculatures at the same time. Sit-ups activate mainly the "global" system muscles (i.e., rectus abdominis, internal and external obliques) and ensure sufficient spinal stiffness (McGill, 2006). The Sit-up test improvement could have been due to inclusion of exercises that more effectively challenged the torso flexors/anterior stabilizers of the spine such as the rectus abdominis and discriminates best on endurance improvements rather than strength (McGill. 2006). The 30-sec maximum sit-up test is found to be reliable and moderately correlated to measures of athletic performance, making it the best field-based assessment to measure core stability (Dendas, 2010). In other case, our programs have lead to benefits increase in the number of push-ups test. The push-up remains one of the best upper-body exercises around, in that it can be performed anywhere, requires no equipment, and is easily adapted to any level of proficiency. The standard push-up works muscles in the shoulders, back of upper arms, and chest. It also exercises muscles in the abdomen, hips, and back, which are tensed to keep the body stiff while it moves up and down. However, these benefits occur only when push-ups are performed properly. It suggested that core-stabilization programs should focus on both directions of trunk rotation to enhance muscle strength and balance. Our program incorporated numerous drills and exercises to improve core strength and stability in both directions, such as twisting lunges with a medicine ball.

Single-Leg Jump-Landing Stabilization Times is a functional, closed-chain test that has been shown to be a reliable test for global core stability (Ross and Guskiewicz, 2005). In our study, an increase on Single-Leg Jump-Landing Stabilization Times is obtained. The improvement in core stability, then throughout the entire plane of motion, leads to maintain of alignment between the hip, knee, and ankle, without the contralateral hip dropping and the knee moving into valgus. Considering the wide variety of movements associated with sports, intuitively, athletes must possess sufficient strength in hip and trunk muscles to provide stability in all three planes of motion (McGill, 2002). The abdominals control external forces that might cause the spine to extend, laterally flex, or rotate and control excessive anterior pelvic tilt. Hip abductors and external rotators also play an important role in lower extremity alignment. In addition to this, biomechanical studies have shown that hip muscle activation significantly affects the ability of the quadriceps and hamstrings to generate and resist forces experienced by the entire leg during jumping. The progression made through the initial stages of a core strengthening program, emphasis should be placed on developing balance and coordination while performing a variety of movement patterns in the three cardinal planes of movement: sagittal, frontal, and transverse. Exercises should be performed in a standing position and should mirror functional movements. Functional training typically requires dynamic stabilization. An advanced core stabilizing program should train reflexive control and postural regulation (Fredericson, 2005).

Soccer players may be predisposed to injuries due to the dynamics involved within the sport. Balance and coordination are the basics for every sports movement. But vitally important within training and competitive soccer match-play due to the fact that the key soccer specific skills are produced from a single-leg stance.

Core stability is considered a key component in training to improve athletic performance. In our study, it seems that there's no effect of 8 weeks of core training on various strength and power performance respectively for sprint test and jump tests (five and squat jump). McGill et al. (2009), assess performance strength and power variables: countermovement jump (i.e., vertical jump), 20-yard shuttle run, 40-yard sprint, one-repetition maximum (1-RM) squat lift, and 1-RM bench press, no significant correlations were observed between core strength and athletic performance variables in the female collegiate soccer players. Other studies have evaluated a group of athletes undergoing a core strengthening program and compared pre- and Post-program sports-specific testing measures versus those of controls. Tse et al. (2005) found no correlation between a core strengthening program and the vertical jump, broad jump, shuttle run, 40-m sprint, overhead medicine ball throw, or 2,000-m maximal rowing ergometer test in college-aged rowers. Unfortunately, the relationship between core stability, plyometrics, and performance in young soccer has not been defined clearly yet. Part of the difficulty in determining this relationship is difficulty in establishing how to best test both core strength and performance. Future studies are needed to work on this field.

To our knowledge this is the first controlled trial quantifying the impact of a specific core stability training program on young soccer performance. In the present study we employed a various training modality that were based on the use of adjustable exercises that force independent stabilization of each limb. The exercise allows for closed kinetic chain exercises with progressive increases in the rotational moments about the joints and the degree of instability. The results suggest that program core training had a positive functional impact on young soccer (13-15 year) trunk and one leg postural performance. The gain in performance might be attributed to an improvement of intra-muscular and inter-muscular coordination rather than hypotrophy.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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