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# Effects of Six Weeks Swiss Ball Training on Balance and Agility of College Soccer Players

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## ABSTRACT

The aim of this study was to determine the effects of six weeks of Swiss Ball Training (SBT) on balance and agility of college soccer players. A total of 19 male soccer players (AGE = 20±1.73 years, BW = 63.42±9.95 kg., H = 172.11±4.45 cm) participated in this study. The subjects were assigned randomly into the control group [CG] (n = 10) and experimental group [EG] (n = 9). The two groups had similar 6-week soccer programme while SBT was given to the EG twice a week, 60 minutes per session, as additional programme. The subjects were tested on static balance using the Standing Stork Test (α =0 .969), dynamic balance using the Four Step Square Test (α = 0.818), and agility using the Illinois Agility Test (α = 0.965). The two groups were equivalent on the pre-test for the three variables revealing insignificant results. Similarly, the post-test results showed insignificant difference in the three variables. However, pre-test and post-test comparison revealed that there was significant improvement in static balance, dynamic balance and in agility for the EG. In conclusion, there is insufficient evidence to support that the SBT could enhance performance in balance and agility of college players.

*Keywords:* Agility, balance, core stabilization, swiss ball training

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## INTRODUCTION

Soccer is a physically demanding sport which requires players to perform high-intensity movements such as short and

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explosive sprints, jumps and repeatedly change of directions during a 90 min match (Bangsbo et al., 2006; Krustrup et al., 2005; Meckel et al., 2009; Reilly et al., 2000a; Stolen et al., 2005). And those actions require overall strength and power production, speed, agility, balance, flexibility, stability, and the adequate level of endurance (Bloomfield et al., 2007; Jovanovic et al., 2011; Krustrup et al., 2005). Often the high-intensity movements such as jumps, runs, and sudden change of directions executed by soccer players would affect the competition results (Bangsbo et al., 2006; Di Salvo et al., 2009; Luhtanen, 1994; Reilly et al., 2000a). Even though these high speed movements constitute only about 10-15% of the total distance covered by soccer players, these activities usually involve movements during crucial situations that result in better ball possessions and better scoring performance (Di Salvo et al., 2009; Reilly et al., 2000a). Previously, Sheppard and Young (2006) used time and motion analysis to prove that the ability to sprint and to change direction while moving were factors which decisively affected sport performance. Those physical attributes were associated with core stability training (CST).

During a soccer game, players performed sprinting and changed direction swiftly according to situation (Salaj & Markovic, 2011; Wong et al., 2012). Soccer players have been reported to change direction during game 1,200-1,400 times every 2-4 seconds (Bangsbo, 1992; Davids et al., 2000; Verheijen, 1997). In addition, it is essential for a player to change directions quickly while running (Salaj & Markovic, 2011; Wong et al., 2012). Consequently, in soccer, agility is of central importance for the optimal performance (Harman et al., 1990). Agility is important either to match or outclass other soccer opponents individually. Agile soccer players can move swiftly to take advantage of the space. In offensive mode, agile soccer players can lose their markers by changing direction quickly and in defensive mode, players can keep up with movement of the player they are tasked to mark. In a longitudinal study of young superior soccer players, Mirkov et al. (2010) observed the potential of agility and coordination in achieving success in soccer, thus should be used for early selection. In fact, earlier studies on soccer had reported that about 11% of the total distance covered during a game was associated with agility with speed. This has increased soccer ball possessions and enhanced goals scoring chances (Little & Williams, 2005; Reilly et al., 2000a; Reilly et al., 2000b).

Agility brought success to soccer (Pojskic et al., 2018) through the integration of neuromuscular coordination, reaction time, speed, strength, and balance. It is considered as a crucial element in soccer performance (Trecroci et al., 2018). It helps soccer players increase their ability to maintain balance, speed, strength and coordination. Soccer is played at great speed and at those speeds, twists and turns cause players to lose balance. However, agility helps players to regain their body balance; agile players could maintain and control proper body positions while moving quickly in various directions (Little & Williams, 2005; Sporis et al., 2010). Furthermore, previous research in soccer has used dynamic balance performance to differentiate levels of competition (Bressel et al., 2007; Butler et al., 2012; Davlin, 2004). The lack of dynamic balance among soccer players can increase the potential of injury risk (Butler et al., 2012). According to Sporis et al. (2010), the improvement in agility can be solicited through the improvement of balance. Research investigations suggest that in addition to muscle strength, power, and speed (Meylan et al., 2009), balance is an important influencing factor of Change of Direction (COD), specifically for soccer players (Sporis et al., 2011). In fact, evidence from cross-sectional studies indicates significant associations between muscle strength and power (Delextrat & Cohen, 2009: Sheppard & Young, 2006), balance (Sekulic et al., 2013), speed (Nimphius et al., 2010) and agility.

In examining young soccer players, Mirkov et al. (2008) reported that the notable advantage of the players appeared to be movement agility. The advantage can be due to efficiency in achieving and maintaining balance while moving. Indeed, the ability to maintain appropriate postural adjustments resulted in balance being maintained which enables COD to be performed frequently (Hammami et al., 2017). Further, static and dynamic balance can be affected by the efficiency of neuromuscular control adaptations, which in turn affects high speed movement among athletes (Jones et al., 2009).

Previous researches (Afyon et al., 2017; Bashir et al., 2018; Kibler et al., 2006) reported that the core training enhanced the core region which played crucial role in stabilization and force generation in sports activities. Core stability (CS) is the ability to control trunk position and motion. CS facilitates the transfer, and control of forces to and from the terminal segments in order to generate optimal forces, during functional activities (Kibler et al., 2006). In addition, CS maintainsfunctional stability in a neutral position and assists in the generation and transfer of energy from the trunk to the extremities (Akuthota & Nadler, 2004; Shirey et al., 2012).

CST is conducted using numerous exercises done with the individual's own body weight which aimed at strengthen the lumbopelvic muscles and deep muscles that keep the spine balanced (Atan et al., 2013). Core exercises train muscles that control and stabilize the movements of the abdomen, waist, and hip of individuals including soccer players (Aksen-Cengizhan et al., 2018). It is believed that core muscle development is imperative in many functional and athletic activities, because core muscle recruitment enhances CS and helps provide proximal stability to facilitate distal mobility (Escamilla et al., 2010). One of the ways to achieve core muscle training effects is through SBT.

The use of SBT for core muscle development has been getting tremendous attention since its inception in the 1960s (Cosio-Lima et al., 2003) and core training has become a major element of sport training plans (Riewald, 2003). Swiss ball exercises provide a wide range of activation of the core musculature (Escamilla et al., 2010) which helps increases individual functional capacity and improves athletic skills (Schilling et al., 2013) as well as improves fitness in sports such as soccer and parkour (Shelvam & Sekhon, 2014). Several researchers have advocated the effectiveness of Swiss ball exercises in improving CS (Borghuis et al., 2008; Santana, 2011) as the unstable surfaces provided by a Swiss ball activates the core muscles considerably in improving trunk stability and balance. Similarly, Srivastav et al. (2016) reported the superiority of SBT over mat surface in improving core stability. CS creates several advantages for neural function (Borghuis et al., 2008) including improving neural recruitment and synchronization of motor units which facilitate rapid nervous system activation while lowering neural inhibitory reflexes. CS exercises may generate more force through influencing the timing pattern of the muscle activation (Borghuis et al., 2008; Kibler et al., 2006), and therefore significantly improved coordinated movement performance. In a study of the effects of SBT on the agility of 30 netball players (19-24 years) for 8 weeks, Shelvam and Sekhon (2014) found that the mean agility score of the EG was significantly different from that of CG. The result was supported by Cosio-Lima et al. (2003), Willardson (2007) and Stanton et al. (2004). Other researchers concur that from a sports performance perspective, greater core stability provides a foundation for greater force production in the upper and lower extremities (Mccurdy et al., 2005; Willardson, 2007).

In examining the effects of short-term SBT on CS and running economy among 18 young male runners, Stanton et al. (2004) found the EG which performed 2 SBT sessions per week for 6 weeks improved CS significantly. Similarly, Sundaram (2016) in a study of basketball players revealed that Swiss ball core exercises were more beneficial than traditional core exercises in improving basketball performance. Other researchers such as Collins (2007) and Prentice (2011) concurred that SBT which trained core and stabilizing muscles played a vital role in body stability and maintaining equilibrium.

The use of SBT which focused on unstable surfaces could be crucial in improving performance as athletes in several sports including soccer often perform on relatively unstable surfaces. Soccer players needed specific training as they ran, kicked ball, jumped and landed on uneven natural turf (Behm & Sale, 1993), SBT could closely mimic the demands of the soccer (Behm et al., 2010). This is supported by Prieske et al. (2015) emphasising that the combination of structured soccer training and CST on stable or unstable surfaces might successfully be applied to improve performance in youth soccer players.

Although SBT has been reported to enhanced physical fitness and sport performance, few studies are associated to soccer. SBT improved strength, endurance, flexibility, and balance in sedentary women

(Sekendiz et al., 2010) while it was effective in improving static and dynamic balance in university students (Yu et al., 2017). In sport, SBT improved agility in netball players (Shelvam & Sekhon, 2014), enhanced basketball performance (Sundaram, 2016) and running economy (Stanton et al., 2004). Previous research related to the effects of SBT on physical fitness in soccer has revealed that SBT has improved agility (Mirkov et al., 2008; Pojskic et al., 2018; Trecroci et al., 2018) and dynamic balance (Butler et al., 2012; Sekulic et al., 2013; Sporis et al., 2010; Sporis et al., 2011). Apparently, there were no other reports on physical fitness measurement involving SBT in soccer.

To date, there have been only two published studies reporting objectively measured physical fitness components using SBT and two using CST in Malaysia. Balakrishnan et al. (2016) found SBT reduced back pain and disability in individuals with non-specific low back pain while Sukalinggam et al. (2012) revealed that SBT enhanced strength in the back and abdominal muscles more in untrained females than males. CST was reported to improve dynamic balance in volleyball players (Sadeghia et al., 2013) and improved power, balance and leg strength in Malaysian rhythmic gymnasts (Nazari & Lim, 2019). Hence, to address the gap in knowledge, this study aimed to measure the effects of SBT on agility and balance of college soccer players.

## METHODS

### Participants

Twenty-two male college soccer players participated in this study. They were members of the same college team and were participating in soccer practice and games three times per week at the time of the investigation. The subjects were assigned into the EG (n = 11) or the CG (n = 11). Nineteen players completed the study (AGE = 20±1.73 years, BW = 63.42±9.95 kg, H = 172.11±4.45 cm). All participants had been involved in soccer training regularly for an average of 5.1 years before the study. Three subjects dropped out (CG=1, EG=2) from this research due to inability to continue the study for 6 weeks. Data from the 19 players were used for final statistical analysis. Previous similar studies used 12 to 19 subjects, thus based on the sample sizes of those studies, the sample size of this study was considered adequate (Stanton et al., 2004 [N=18, CG=10, EG=8]; Myer et al., 2006 [N=19: CG=8, EG=11]; Cressey et al., 2007 [N=19: CG=10, EG=9]; Thomas et al., 2009 [N=12: EG=6, CG=6]). Prior to the commencement of this study, the subjects filled-up the Physical Activity Readiness Questionnaire (PAR-Q) to rule out participation contraindications. PAR-Q results showed that all the subjects were healthy and eligible to participate in this study. The subjects also signed the consent form after the briefing on the methods, procedures, benefits and potential risk. The Ethics Committee of Tunku Abdul Rahman University College approved this study.

## Design of the Study

The design of this study was pre-test-intervention-post-test. The subjects were assigned randomly into CG and EG after pre-tests on static balance using the Standing Stork Test (Johnson & Nelson, 1986), dynamic balance using the Four Step Square Test (Whitney et al., 2007), and agility using the Illinois Agility Test (Getchell, 1979). The assignment of subjects into the 2 groups were based on the computed total Z-scores of the 3 pre-tests. The systematic-counter-balancing method was used to assigned them into the 2 groups and the Fishbowl method was used to assign them into the CG and EG. The two groups underwent a similar 6-week soccer programme while supplementary SBT was administered to the EG twice a week, 60 minutes per session for the duration. Post-test was conducted for both groups after the end of the six weeks.

## Procedures

This study involved three phases of pre-testing, 6-week training/intervention, and post-testing. Pre-test was conducted before the 6-week training/intervention and post-test was carried out after the 6 weeks period. Familiarization session was held before the pre-test to ensure subjects understood the testing procedures. Participants performed the EG or CG programme thrice weekly (two hours per session) for 6 weeks after pre-testing. Intervention programmes for the EG were conducted by the researcher while the coach assisted in monitoring subjects' attendance. All subjects were instructed not to participate in other physical training other than the mandatory programmes for each group. After the 6-week period, similar 3 tests were conducted in the post-test.

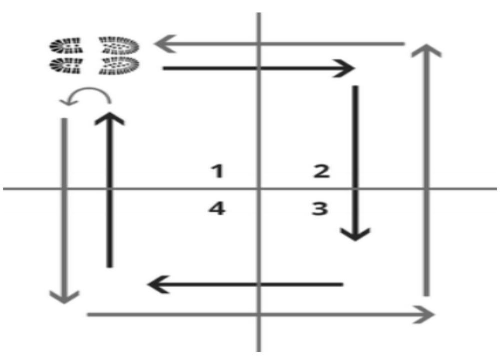
## Exercise Testing

Before the pre-test, a short briefing was provided to inform the subjects about the tests. A twenty minutes standardized warm up activities was conducted after the briefing. Activities done during the warm up included slow jogging and static stretching of the soccer programme. The testing session started with Standing Stork Test (Johnson & Nelson, 1986), followed by the Four Step Square Test (Whitney et al., 2007), and Illinois Agility (Getchell, 1979) in sequence. Prior to the pre-test, the Standing Stork Test and Four Step Square Test were pilot tested using Tunku Abdul Raham University College Sports and Exercise students (N= 31, 20.03±1.8 years old) while Illinois Agility Test was verified in Malaysia by Heang et al. (2012).

***Standing Stork Test*** (Johnson & Nelson, 1986; r=0.85-0.87, pilot = 0.969).

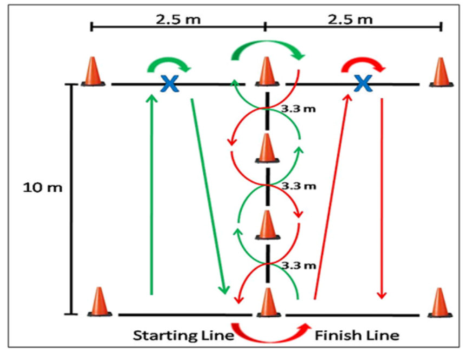
This test measured static balance. The subjects performed the test barefooted. The performer stood on the foot of the dominant leg, placed the other foot against the inside of the supporting knee, and placed the hands on the hips. On the signal "Go," the performer raised the heel of the dominant foot from the floor and attempted to maintain balance as long as possible The trial ended when the hands were moved from the hips, when the ball of the dominant leg moved from its original position, or when the heel touched the floor. Three trials were administered. Best time in seconds of the three trials performed was recorded.

***Four Step Square Test*** (Whitney et al., 2007; r=0.86-0.96, pilot=0.818)




This test measured dynamic balance. The subject stood in square 1 facing forward. Upon instruction 'GO', the subject stepped as fast as possible in the clockwise direction into each square in the following sequence: 2, 3, 4, 1, then immediately moved counter clockwise from 4, 3, 2, 1. Best time in seconds of two trials was recorded.

***Illinois Agility Test*** (Getchell, 1979; Raya et al., 2013, 0.65; Heang et al., 2012, 0.965) Subjects lied prone with hands pointed forward. On the 'Go' command the subject jumped up quickly and negotiates the course around the cones to the finish line. Subjects were given 3 minutes of rest between trials.




Average time in seconds in three trials was scored.

**Training Programme**

Training programmes were conducted three sessions weekly for 6 weeks. The Soccer Training Programme in Table 1 was for both the EG and CG. The SBT Programme in Table 2 was provided to the EG and was adapted from Stanton et al. (2004) and Goodman (1999).

**Data Analysis**

Research data were analysed using SPSS 23.0 software (IBM, USA). All basic data were presented as means, standard deviations and percentages. Background information such as age, body weight, height and soccer training experience were also reported. Independent t-tests were performed to determine if any significant differences existed between CG and EG before and after the 6 weeks study period. Paired sample t-tests were used to determine if significant differences existed between the pre-test and post-test mean scores for each group on the three dependent variables. The statistical significance was set at $p < 0.05$.

Table 1
*Six weeks soccer programme for control group and experimental group*

| Programme | Tuesday | | | | | | Thursday | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W1 | W2 | W3 | W4 | W5 | W6 | W1 | W2 | W3 | W4 | W5 | W6 |
| Warm-up | 10 | 10 | 10 | 10 | FM | NT | 10 | FM | FM | 10 | NT | NT |
| Rest | 5 | 5 | 5 | 5 | | | 5 | | | 5 | | |
| Specific Warm-up | 20 | 10 | 10 | 10 | | | 20 | | | 10 | | |
| Rest | 5 | 5 | 5 | 5 | | | 5 | | | 5 | | |
| Individual attacks/defences | 20 | - | - | - | | | 20 | | | - | | |
| Pass drills | - | 20 | - | - | | | - | | | - | | |
| Defence Formation | - | - | - | 20 | | | - | | | - | | |
| Rest | 5 | 5 | - | 5 | | | 5 | | | - | | |
| Full match simulation | 55 | 65 | 65 | 55 | | | 55 | | | 90 | | |

FM = Friendly Match NT = No Training

Table 2
*Six weeks SBT programme*

| No | Exercise | Week 1 | | | | Week 2 | | | | Week 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sets | Reps | Time(s) | Rest(s) | Sets | Reps | Time(s) | Rest(s) | Sets | Reps | Time(s) | Rest(s) |
| 1 | Balanced Sitting | 1 | | 60 | 30 | 1 | | 60 | 30 | 1 | | 60 | 30 |
| 2 | Elbow Bridge | 2 | | 25 | 15 | 2 | | 35 | 15 | 2 | | 45 | 20 |
| 3 | Side Bridge | 1 es | | 20 es | 10 | 2es | | 20es | 10 | 1es | | 35es | 15es |
| 4 | Forward Roll on Knees | 2 | 8 | | 60 | 2 | 8 | | 60 | 2 | 10 | | 60 |

Table 2 *(Continued)*

| No | Exercise | Week 1 | | | | Week 2 | | | | Week 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sets | Reps | Time(s) | Rest(s) | Sets | Reps | Time(s) | Rest(s) | Sets | Reps | Time(s) | Rest(s) |
| 5 | Hands On Ball | 1 | | 30 | 15 | 1 | | 40 | 20 | 1 | | 45 | 20 |
| 6 | Shoulder Bridge – both feet down | 2 | 8 | | 60 | 2 | 8 | | 60 | 2 | 10 | | 60 |
| 7 | Shoulder Bridge – elbows down/one leg up | | | | | 1es | | 20es | 10 | 1es | | 30es | 15 |
| 8 | Supine Lateral Roll | 2 | 8es | | 60 | 2 | 8es | | 60 | 2 | 10es | | 60 |
| 9 | Alternating Superman | 2 | 8es | | 60 | 2 | 8es | | 60 | 2 | 10es | | 60 |
| 10 | Lunge | 2 | 8es | | 60 | 2 | 8es | | 60 | 2 | 10es | | 60 |
| 11 | Crunch | 3 | 30 | | 60 | | | | | 3 | 20 | | 60 |
| 12 | Heal Grab Crunch | | | | | 3 | 25 | | 60 | 2 | 20 | | 60 |
| 13 | Supine Russian Twist | 2 | 8es | | 60 | 2 | 8es | | 60 | 2 | 10es | | 60 |

Table 2a.

*Six weeks SBT programme. (Continued)*

| No | Exercise | Week 4 | | | | Week 5 | | | | Week 6 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sets | Reps | Time(s) | Rest(s) | Sets | Reps | Time(s) | Rest(s) | Sets | Reps | Time(s) | Rest(s) |
| 1 | 4 Point Kneeling | 1 | | 60 | 30 | 1 | | 60 | 30 | 1 | | 30 | 15 |
| 2 | 2 Point Kneeling | | | | | | | | | 1 | | 30 | 15 |
| 3 | Side Bridge | 2es | | 30es | 15 | 2es | | 35es/30es | 15 | 2es | | 40/25es | 30 |

Table 2a.
*Six weeks SBT programme. (Continued)*

| No | Exercise | Week 4 | | | | Week 5 | | | | Week 6 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sets | Reps | Time(s) | Rest(s) | Sets | Reps | Time(s) | Rest(s) | Sets | Reps | Time(s) | Rest(s) |
| 4 | Forward Roll on Knees | 2 | 10 | | 60 | 3 | 8 | | 60 | 3 | 8 | | 60 |
| 5 | Shoulder Bridge – both feet down | 2 | 10 | | 60 | 3 | 8 | | 60 | 3 | 8 | | 60 |
| 6 | Hip Bridge – both feet down/one leg up | 1 | | 30/10es | 60 | 1 | | 30/20es | 60 | 1 | | 40/25es | 60 |
| 7 | Supine Lateral Roll | 2 | 10es | | 60 | 3 | 8es | | 60 | 3 | 8es | | 60 |
| 8 | Alternating Superman | 2 | 10es | | 60 | 3 | 8es | | 60 | 3 | 8es | | 60 |
| 9 | Lunge | 2 | 10es | | 60 | 3 | 8es | | 60 | 3 | 8es | | 60 |
| 10 | Pike | 2 | 5 | | 30 | 2 | 7 | | 30 | 1 | 10 | | 30 |
| 11 | Diagonal Crunch | 1 | 10es | | 60 | 1 | 15es | | 60 | | | | |
| 12 | Crunch+Hip Extension | | | | | | | | | 1 | 20 | | 60 |
| 13 | Supine Russian Twist | 2 | 10es | | 60 | 3 | 8es | | 60 | 3 | 8es | | 60 |

## RESULTS

Pre-test statistical analysis in Table 3 showed insignificant results confirming that EG and CG were equal in all the three parameters, before the study started. Similarly, post-test in Table 4 showed non-significant results for all the three parameters for both groups. In Table 5, The pre-post mean scores comparison of the three parameters for each group revealed higher improvement in EG for Standing Stork Test (76.4%), and greater improvement in dynamic balance (19.4%) and agility (1.5%) as compared to CG.

## DISCUSSION

The study examined the effects of SBT on agility and balance of college soccer players. The post-test results in this research showed insignificant differences between EG and CG in Static Balance, Dynamic Balance and Agility mean scores. This has diminished the potential of SBT in affecting static balance, dynamic balance and agility within a short duration. This result partially supported Ozmen and Aydogmus's (2016) finding related to agility. In a study of the effects of Core Strength Training (twice a

Table 3

*A comparison of pre-test mean scores static balance, dynamic balance and agility between CG and EG*

| Test | Group | n | Mean±SD | t-value | Sig. |
|---|---|---|---|---|---|
| SST | Control | 10 | 20.50±2.075 | 0.47 | 0.65 |
| | Experimental | 9 | 16.64±1.439 | | |
| FSST | Control | 10 | 4.09±0.42 | 0.03 | 0.98 |
| | Experimental | 9 | 4.08±0.63 | | |
| IAT | Control | 10 | 17.48±0.99 | -0.17 | 0.87 |
| | Experimental | 9 | 17.56±1.09 | | |

* Significance level is set at $p < 0.05$

Note: SST = Standing Stork Test FSST = Four Step Square Test IAT = Illinois Agility Test.

Table 4

*A comparison of post-test mean scores static balance, dynamic balance and agility between CG and EG*

| Test | Group | n | Mean±SD | t-value | Sig. |
|---|---|---|---|---|---|
| SST | Control | 10 | 24.23±1.943 | -0.56 | 0.58 |
| | Experimental | 9 | 29.35±2.015 | | |
| FSST | Control | 10 | 3.46±0.42 | 0.81 | 0.43 |
| | Experimental | 9 | 3.30±0.44 | | |
| IAT | Control | 10 | 17.88±1.06 | 1.29 | 0.21 |
| | Experimental | 9 | 17.29±0.93 | | |

* Significance level is set at $p < 0.05$

Note: SST = Standing Stork Test FSST = Four Step Square Test IAT = Illinois Agility Test.

Table 5

*Pre and post-test mean scores comparison for static balance, dynamic balance and agility between CG and EG*

| Test | Group | N | Test | Mean±SD | t-value | Sig. | % Improvement |
|---|---|---|---|---|---|---|---|
| SST | Control | 10 | Pre | 20.50±2.08 | -0.94 | 0.37 | 18.2% |
| | | | Post | 24.23±1.94 | | | |
| | Experimental | 9 | Pre | 16.64±1.44 | -2.75 | 0.03* | 76.4% |
| | | | Post | 29.35±2.02 | | | |
| FSST | Control | 10 | Pre | 4.09±0.42 | 3.74 | 0.00* | 15.4% |
| | | | Post | 3.46±0.42 | | | |
| | Experimental | 9 | Pre | 4.08±0.63 | 6.87 | 0.00* | 19.4% |
| | | | Post | 3.30±0.44 | | | |
| IAT | Control | 10 | Pre | 17.48±0.99 | -1.92 | 0.09 | -2.4% |
| | | | Post | 17.88±1.06 | | | |
| | Experimental | 9 | Pre | 17.56±1.09 | 2.23 | 0.06 | 1.5% |
| | | | Post | 17.29±0.93 | | | |

* Significance level is set at $p < 0.05$.
Note: SST = Standing Stork Test FSST = Four Step Square Test IAT = Illinois Agility Test.

week for 6 weeks) on dynamic balance and agility of badminton players, they found no significant difference in agility after 6 weeks between EG and CG but significant difference was reported for dynamic balance between EG and CG. The results of this study were contrary to the findings by Bashir et al. (2018) which examined the effects of core training on dynamic balance and agility among junior hockey players whereby it was found that core training had improved dynamic balance and agility of the players. In study of soccer players, Afyon et al. (2017) reported that the 8-week soccer training with core training had improved players' speed and agility.

**Effects of Swiss Ball Training on Balance**

The post-test results of this study revealed that there were no significant differences between EG and CG for static balance and dynamic balance. However, the performance of the EG was better than CG in static balance (76.4% vs. 18.2%) and dynamic balance (19.4% vs. 15.4%). Similar result was reported by Callaghan et al. (2010) where static spinal stability exercise protocol using Swiss balls had improved back endurance in sedentary people. SBT and conventional physiotherapeutic interventions including traditional techniques such as stretching, strengthening, PNF incorporate the improvement of central, neural and peripheral functioning and thus improves balance (Muniyar & Darade, 2018). Trunk control requires an appropriate sensiori motor ability in order to provide a stable foundation for balance control. It has been shown that the trunk stabilization exercises on unstable surfaces shows improvement in balance (Lehman et al., 2005; Stevens et al., 2006). A study by Nayak et al. (2012) revealed that SBT improved the trunk control after stroke. SBT has an effect on trunk muscle activity as it influences the anticipatory postural response which might influence the trunk control.

Filipa et al. (2010) investigated the effectiveness of 8 weeks neuromuscular training programme which pivoted on core stability and lower extremity strength on dynamic balance. The programme had improved dynamic balance.

Swiss-ball exercises were extensively used because they could improve strength, endurance, flexibility, coordination, and balance (Karatas et al., 2004). Yu et al. (2017) in a study to investigate the effects of Medicine-ball and Swiss-ball exercises on static and dynamic balance revealed that 6-week exercise programme was effective in improving static and dynamic balance of young adults (Mean age = 22.2 years). Similarly, in examining the effects of an 8-week combination programme of core and balance training on single-leg kicking activity among 24 male soccer players, Erdem and Akyüz (2017) found the combination programme had enhanced balance parameters and soccer skills.

Another study of the effectiveness of Swiss ball on improving static and dynamic balance was conducted by Baljinder (2012). In examining 6-week Swiss ball programme on varsity basketball players, Baljinder identified that 45-minute daily session of Swiss ball exercises for 6-week was adequate to improve static and dynamic balance in the EG as compared to CG. Similarly in badminton, Hassan (2017) reported that an 8-week CST had helped EG players improved dynamic balance in the lower extremities. The above-mentioned results were supported by Lacono et al. (2014). In a study of Core Stability Training Programme (CSTP) effects on static and dynamic balance abilities of 20 young male soccer players, Lacono et al. (2014) found that CSTP significantly improved the static and dynamic balance parameters. In another study to compare the effects of 6-week core exercises programme in terms of core stabilization and balance performance (3 days/week, 40 minutes/day), using Swiss Ball (SBC) and Theraband (TBC) on 22 women aged 25-46 years old, Aksen-Cengizhan et al. (2018) reported that although insignificant differences were found in the post-test mean scores between SBC and TBC groups there was a significant improvement in balance and core stabilization test scores.

Exercises that use balls such as Swiss ball use various parts of the body so that wide-ranging activities could be performed, exceeding the potential of using fixed floors (Chung et al., 2013). Thus, exercising on balls could improve the dynamic balance, the flexibility and stability of the spine (Marshall & Murphy, 2005). As suggested by Anderson and Behm (2005), balance could be maintained through unconscious reflexes of proprioceptive system which obtained information from the joints and muscles. In addition, Lehman et al. (2005) had indicated that local muscles had a greater proprioceptive function, and if the Swiss-ball could exert considerable stresses on the muscles, that could trigger an improved balance effect after SBT.

In investigating the effects of trunk stabilization exercise on the transvers abdominis (TA) and internal oblique (IO) muscle activity and balance ability of average participants, Cha (2018) reported that the trunk stabilization exercise improved the balance ability and increased the activity of the TA and IO muscle. In soccer players, the trunk stabilization exercise for 4 weeks resulted in a significant increase in the muscle activity of the TA and IO muscles (Kim et al., 2010).

**Swiss Ball Training and Agility**

The post-test result of this study revealed that there was no significant difference between EG and CG for agility. The performance of the EG was better than CG in agility. In fact CG's agility had a negative improvement (-2.4%) as compared to EG positive 1.5% improvement.

The negative improvement in CG did not echo the findings of a research on the effects of stretching on agility by Amiri-Khorasani et al. (2010). It was found that there was significant improvement in agility performance following dynamic stretching as compared to static stretching in both less and more experienced players. Stretching was performed as warm-up activity before soccer training and this could improve agility.

The improvement in agility for EG in this study could be explained by research carried out by Mills et al. (2005). These researchers studied 30 college female volleyball and basketball players aged 18-23 years who were randomly divided into treatment group (TG), pseudo-treatment group (PTG), or control group (CG). Training for the treatment group focused on voluntarily activating the local stability muscles; transversus abdominus (TrA), lumbar multifidi (LM), and the pelvic floor (PF). Results showed improvement in agility (8.8 ±0.7 s) and leg power (32.3 ±4.5 cm) of TG. The training was similar to SBT. Similarly, the result of EG in this study was supported by Pankajbhai and Shantilal (2015) who assessed the effects of CST on running speed of female cricket players, and revealed that 2-week CST improved running speed and agility of 20 female cricket players.

In another study, Afyon et al. (2017) examined the consequences of 8-week core training on speed and agility of soccer players. The experimental group had core training on 2 days (30 minutes per session) of the 4 days per week soccer training while control group had only the soccer training programme. The research results showed non-significant difference in 30m sprint test (CG: 4,56±0,61; EG: 4,53±0,33 sec respectively), Illinois agility test (CG: 16,65 ± 1,03; EG: 16,34 ± 1,15 sec respectively) and T-drill agility test (CG: 9,74 ± 0,98; EG: 9,51 ± 0,17 sec respectively). However, the agility [Illinois Test: CG 4.6% vs. EG 8.9%; T-Drill Test: CG 7.4% vs. EG 14.7%] and speed performance [30-m run test: CG 1.1% vs. 2.0%] of the players improved positively for both groups. This was supported by

Nesser et al. (2008) who found significant relationship between core stability and sprint, vertical jump, agility in male soccer players.

Cressey et al. (2007) studied the effects of 10-week lower-body exercises performed on unstable surface in collegiate males' soccer players. Nineteen players aged 18-23 years were divided into 2 groups (EG=10, CG=9). EG complemented regular training programme with lower-body exercises on inflatable rubber discs and CG performed the same exercises on stable surfaces. No statistically significant differences were apparent between groups. However, significant improvements were observed in both the EG (-2.9%) and the CG (-4.4%) groups over baseline. The result did not show the superiority of working out on unstable surface.

Rebutting the finding of Cressey et al. (2007), Gortsila et al. (2013) reported that different training surfaces (hard or sand surface) had varied effects on agility and passing skills of prepubescent female volleyball players. They found the group that had training on sand surface significantly improved agility as compared to the other two groups that trained on hard surface.

## CONCLUSION

The pre-post mean scores have shown that SBT has resulted greater improvement in static balance, dynamic balance and agility in EG as compared to CG. The results support the fact that SBT could be used to provide improvement in the aforementioned measures in college level soccer players. In conclusion, this study provides practical implications for soccer players, physiotherapists, strength and conditioning specialists who can benefit from SBT. Future research could apply longer training duration and involves soccer players from different levels.

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