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ORIGINAL ARTICLE

CORE STABILITY TRAINING VERSUS FOOTWORK EXERCISES ON AGILITY AMONG AMATEUR SOCCER PLAYERS

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ABSTRACT

Introduction: Agility improves body control by facilitating the development of the muscles and tendons in all main joints and preventing injuries through the repeated practice of appropriate movement. "Core training" is a technique for strengthening the lumbopelvic hip region muscles, which are important for core stability. Footwork exercises termed as agility ladder drills that uses rope barriers like ladders to improve coordination, leg power, and agility. Objective of the study is to determine and compare the effects of Core stability training (CST) and Footwork exercises (FWE) on agility among amateur soccer players. **Methods**: A sample of 72 male soccer players, meeting the inclusion and exclusion criteria, was selected for this study. They were divided into two intervention groups: Group A received CST and Group B received FWE for 3 days per week for 6-weeks. The pre-test and post-test were assessed using the Illinois agility test (IAT) for agility. The data was recorded in seconds(s). **Result:** The study found that both the groups were individually effective i.e, Group A - ($p<0.001$; $t=12.656$) & Group B – ($p<0.001$; $t=10.475$), but no significant difference was found when compared pre-test and post-test in between the groups. **Conclusion:** Both the interventions were equally effective in improving the agility of the amateur soccer players. Therefore, the study concludes with the acceptance of null hypothesis which states that there is no significant difference between CST and FWE on agility among amateur soccer players.

Keywords: Core Stability Training; Footwork Exercises; Ladder drills; Agility; Soccer; Amateur soccer players; Illinois Agility Test.

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INTRODUCTION

A wide range of people participate in soccer. Soccer is played by players of various ages, and diversity in the sport. Soccer does not discriminate based on a player's gender, height, or weight. [1] The performance of a soccer match is known to be affected by a player's ability to execute a variety of high-speed movements. [2]

Soccer is based on muscular performance that demands players to execute high-intensity, repetitive motions such rapid acceleration and deceleration, direction changes, jumping, and landing. Throughout the game, there are periodic physical activities that require vigorous running in various directions. [3] Soccer is also known as football, and most people think of soccer as an aerobic sport that requires regular intervals of physical exercise. [4]

The number of players—22 people in total—that are on the field of play. Each team consists of eleven players, one goalie, and ten moving players. A football player can score with a header, a shot on goal, or an involuntary variation. They can even unintentionally perform another fundamental, such as a cross. [5] The August 2021 edition of FIFA's Rules and Regulations on the Status and Transfer of Players states that players who play professional football are classified as either amateurs or professionals. A player is considered a professional if they are under contract with a club and receive a higher salary for playing football than they actually spend. All the other players are considered amateurs. Kaplan T. et.al. Investigated and found out that there is a difference between professional and amateur soccer players in their running and agility performances. Professional soccer players running speed and agility performances are higher than those of amateur soccer players. Agility was shown to be the most powerful discriminator between the two standards of proficiency. [2]

Bangsbo emphasized that improving strength, speed, and agility along with a combination of aerobic and anaerobic (even maximal) characteristics are essential for successful, professional football careers. [6]

Sunje E. et al., investigated the abilities of sprint, agility, and vertical jump to determine the differences between professional and amateur soccer players in Bosnia and Herzegovina who represent two competition levels. They concluded that professional and amateur soccer players in Bosnia and Herzegovina differ statistically significantly by age, linear speed ability, and agility. [7]

Michilidas et. al., examined and compared the physical fitness of Greek soccer players participating in teams of different divisions before the beginning of the preparation period. Semi-professionals presented significantly faster values in the 30m sprint and agility tests compared to amateurs by 7.6% and 8.2%, respectively. Semi-professionals performed better on all physical condition tests than amateur players. [8]

Professional soccer players run an average of 8–12 kilometres during a match, according to research by several authors. In a football game, there are sprints that last between 2 and 4 seconds on average every 90 seconds. It is estimated that soccer players average thirty sprints, roughly 600 direction changes, and ten to fifteen jumps during a game, further supporting the significance of sprint, agility, and vertical jump in the sport. [7]

Soccer requires players to be competitive in various elements of fitness, including aerobic and anaerobic ability, muscle strength, flexibility, and agility. [8] The ability to maintain and control the position of the body while rapidly changing direction in a series of movements is called agility (Twist, Benicky, 1995; Sheppard, Young, 2006). Agility is also defined as the combination of strength, speed, balance, and coordination (Draper and Lancaster 1985). [2] Agility enhances body control through repeated practice of appropriate movement, which helps to develop the muscles and tendons in all major joints and helps to prevent injuries. [9]

To be a professional player, a player must have high-level skills, good reflexes, and be quick and agile around the field. [10] It has been established that balance, coordination, power, and speed are the components of agility. For elite, recreational, and amateur athletes who need to be able to rapidly change directions on all planes in order to compete. [11]

There are multiple number of tests designed to assess agility in players, e.g., the hexagon test, 505 agility test, 40-yd shuttle run, K- Test, T-test, Illinois agility test, etc. The National Strength and Conditioning Association (NSCA) characterized the T-Test & Illinois agility test and found that it was a valid and reliable measure of lower-body power, agility, and sprinting speed as well as a predictor of sports performance in college-aged men and women who were not impaired. [11]

The Illinois Agility Test (IAT) was introduced in 1942, An initial prone posture, a quick change to standing, and a series of multidirectional manoeuvres around obstacles are features of the IAT that set it apart from other tests. [11]

Different writers have given different definitions for "Core." Some state that it is the whole trunk, including all the muscles extending from the shoulders and hips. Willardson defined it as the lumbopelvic region where everything above the pelvis and below the sternum is considered core musculature. It is defined by Borghuis et al. as the musculature of the hip and all the muscles around the lumbar spine. The purpose of the core is to prevent serial distortion patterns by maintaining body balance and alignment both statically and dynamically. [12]

The muscles that make up the core of the body include the psoas major muscle, multifidus muscles, transverse abdominal muscle, and abdominal external oblique muscle.[10] Due to the widespread use of core stability training regimens in the context of physical rehabilitation and fitness, the term "core stability" gained popularity in research near the beginning of the 20th century.[12] The lumbopelvic-hip structures and musculature's capacity to sustain compressive stresses on the spine and restore the body's balance following disruptions is known as core stability.[10]

Research on the effects of core stability training (CST) on athletic performance in sports has been conducted and is still ongoing. Previous studies showed that in sports like badminton, handball, baseball, basketball, football, swimming, tennis, rhythmic gymnastics, and modern dance, a CST program improved a variety of general performance as well as sport-specific performance. [3]

Important elements of core stability are the strength, power, endurance, and coordination of the muscles of the spine, hips, and abdomen. Stable core muscles provide the base for upper and lower extremity muscles to

accelerate body segments and transmit force between proximal and distal body segments during sports activity. [10]

The term "Core training" refers to a type of exercise whereby body weight is utilized to strengthen the lumbopelvic hip region muscles, which are important for core stability. Athletes are able to withstand the training load and perform technical moves more effectively when their core area is developed.[13] Rehabilitation regimens for lower limb and trunk injuries include core training as a crucial component that helps to avoid injuries in athletes.[12] Although each research contains a distinct core program to follow, recent studies have examined the impact of core stability exercises on lower limb and upper limb performance in various sports activities.[14]

Footwork is defined as the ability to accelerate or decelerate on the field while changing direction to increase accuracy and performance. Starting, moving, braking, and returning are the four components of footwork. [15] Players with strong footwork may receive the ball faster, which allows them to manipulate the situation and score points. Therefore, players need to be given detailed and methodical footwork training in order to develop excellent footwork. [16] A football player needs to be agile, particularly when using dribbling moves. The agility ladder drill is a technique used to increase agility. The purpose of the agility ladder drill is to increase leg power, agility, and coordination through the use of rope obstacles like ladders. Exercises using ladder drills, such as the in-out and ickey shuffle, may greatly improve speed and agility. [17] A football player needs to be agile, particularly when using dribbling moves. [18]

The agility ladder drill is a technique used to increase agility. The purpose of the agility ladder drill is to increase leg power, agility, and coordination through the use of rope obstacles like ladders. Exercises using ladder drills, such as the in-out and ickey shuffle, may greatly improve speed and agility. [18] The idea behind agility ladder training is to apply a movement in a certain direction with different combinations and finish the activity in the least amount of time. The agility ladder exercises are thought to have a good impact on coordination, speed, and agility. [19]

Agility ladder drills are footwork exercises using rope obstacles such as ladders with the goal to increase leg power, agility, and coordination (Hastuti et al., 2021; Adji et al., 2022). The purpose of the agility ladder drills training method is to help athletes develop their ability to move fast, quickly change direction, and pass the ladder rope as well as a variety of different obstacles (Nasrulloh et al., 2022). The ladder drill training pattern has a flat jump area in the form of an agility ladder. Athletes are said to improve their coordination, leg strength, speed, and agility by using this technique. [20]

Ladder drill is the most popular training in the world, because it helps players with a variety of motions that improve coordination and boost speed and agility. Agility's supporting elements are speed, coordination, flexibility, and balance. [21] Agility ladder can be a multipurpose tool that can also improve agility and power. Ladder drills use stairway workouts on the ground or floor where an athlete is required to jump and move fast to the right and left to train various footwork. Since it requires the entire body to move, this exercise is a great way to improve physical condition, especially for those that need explosive power

capabilities like jumping, punching, kicking, and quick running. [22] When sprinting without the ball or to handle the ball, soccer players with poor agility will not be able to participate in a functional performance against opponents who may have high agility. [23]

Thereby, a low level of agility in amateur players may influence the level of performance in football players.

Need For the Study

Agility is defined as the ability to quickly change direction and move one's limbs, as well as change direction with the entire body. It involves the ability to change direction quickly, accelerate, decelerate, and maintain balance while performing various soccer-specific movements. Developing increased agility offers several benefits, such as enhanced intramuscular coordination, improved body control during rapid motions, and a lower risk of injury or recurrence.

Core stability training (CST) enhances athletic performance in sports like badminton, handball, baseball, basketball, football, swimming, tennis, rhythmic gymnastics, and modern dance, improving both general and sport-specific performance. Core stability involves the strength, power, endurance, and coordination of spinal, hip, and abdominal muscles, which provide a stable foundation for efficient force transmission and quick body segment acceleration during sports activities. The majority of performance gains are associated with core training.

Footwork improves the game more than physical ability on the field. Footwork training also improves the dribbling abilities of a soccer player. An amateur player has to have strong agility skills in order to play professional soccer.

Although various studies have been done on the agility of soccer players. Both Core stability and footwork exercises have been proven effective in increasing player's agility.

Therefore, there arises a need of the study to compare the effects of two training methods on agility and to determine which of these two training methods has superior effects in increases agility among amateur soccer players.

Objectives of the Study:

1. To determine the effect of core stability exercises on agility among amateur soccer players.
2. To determine the effect of footwork exercises on agility among amateur soccer players.
3. To compare the effects of core stability exercises versus footwork exercises on agility among amateur soccer players.

MATERIALS AND METHODS

Source of data:

- Padmashree group of Institutions, Bangalore.

Method of collection of data

- **Population:** Amateur Soccer Players.
- **Sample design:** Convenience sampling
- **Sample size:** 72
- **Type of study:** Comparative Study
- **Duration of study:** 6 months

Inclusion Criteria:

- Active Male Soccer players
- Age group 18-25 years
- Playing Soccer for more than 1 year
- Players who play Soccer for atleast 2-hours/day
- Players with BMI ranging from 18 to 24

Exclusion Criteria:

- Players with Low back pain from past 4-weeks
- Players with Upper limb and Lower limb Fractures in the past 3-months
- Players with Chronic ligament injuries
- Players with Ankle instability/Recurrent Ankle sprains
- Players with any Existing Musculoskeletal, Neurological, Cardiorespiratory Conditions
- Players with any Visual and Vestibular impairments
- **Materials Required:** Pen/Pencil, Paper, Consent form, Soccer ball, Agility cone markers, Agility Ladde, Stopwatch, Measurement tape and Weighing scale
- Flat non-slip surface

METHODOLOGY

Ethical clearance was obtained from the Institutional Ethical Committee with the reference No. PIEC/PIP/14/2024 dated on 20/06/2024. The participants were selected for the study based on the inclusion and exclusion criteria. The Informed consent was obtained from all the participants. The purpose of the study was then explained to all the selected participants. Demographic information such as name, age, gender, height, weight, number of playing years was documented.

Procedure: The participants were divided equally into two groups, Group A and group B. Group A received Core stability training (CST) and Group B received Footwork exercise (FWE). A pre-test was conducted for all the selected participants prior to the training session using Illinois Agility Test (IAT). All the instructions regarding the pre-test were explained in detail to all the participants and 3-4 trail runs was conducted for the same. The test data was collected in seconds (s).

Both the groups received the respective interventions for a period of eight weeks, attending sessions three times a week. Both the groups received a warm-up session and a cool-down session for 10-minutes each prior to each training session that included light stretching exercises that specifically targets the lower limbs.

The post-test data was collected from both the groups after the intervention period using Illinois agility test (IAT).

Intervention:

Group A: Core Stability Group

Core Stability Training includes the following exercises:

Weeks	Exercise	Repetition	Resting time	No. of sets	Rest between sets.
WEEKS 1-4	Sit Up	15 Reps	1 min	3	2 min
	Leg Raise	15 Reps	1 min	3	2 min
	Side Bend	15 Reps	1 min	3	2 min
	Superman	15 Reps	1 min	3	2 min
	Plank	30 secs	1 min	3	2 min
WEEKS 5-8	Leg Raise	15 Reps	1 min	3	2 min
	Flutter kicks (right-left)	15 Reps	1 min	3	2 min

	V-sit up	15 Reps	1 min	3	2 min
	Lying Hip Raise	15 Reps	1 min	3	2 min
	Russian Twist	15 Reps	1 min	3	2 min
	Plank	45 secs	1 min	3	2 min

Group B: Footwork Group

Footwork Training includes the following exercises:

Weeks	Footwork Drills	Repetitions & sets	Rest per set
1-2 Weeks	Warm-up exercises, Two-foot forwards, Lateral shuffle, Ali shuffle, Skiers	15 x 3	1 min
3-4 Weeks	Icky shuffle, Single Leg In & Out, Lateral In & Out, Crossover, Figure of 8 5m sprint	15 x 3	1 min
5-6 Weeks	Foot Exchange, Reverse Crossover, Hip Twist, Carioca drills, Squat jumps	15 x 3	1 min
7-8 Weeks	Two Footed Hop, One Footed Hop, Backpedal sprint, Squat jumps	15 x 3	1 min

Figure 1: Setting up the IAT course

OUTCOME MEASURE:

Illinois Agility Test: Used to assess the agility

Procedure: The test was prepared using a 10-m long, 5-m wide test track by placing three cone markers with 3.3-m of distance between them in a straight line. The players were instructed to

carry out gentle warm-up and light stretching exercises focusing on the lower limbs for at least 5 minutes before taking up the test. The players were informed about the track before the test and 3-4 trials was done. The player then begins by lying flat, facing cone 1. Then they sprint towards cone 2, which is positioned 10m away, and continued running for another 10m to reach cone 3. Next, they weaved through cones 3, 4, 5, and 6, before returning 3.3m apart and run towards cone 7, which was also 10m away. The finish line was at cone 8. We used a stopwatch to measure the player's agility performance in seconds (s). Then the reading was noted and documented.

Agility Track Course

Figure 2: Subjects performing Illinois Agility Test (IAT)

Figure 3: Subjects performing Core Stability Training (CST)

Data Analysis

The data based on background variables and outcome measures were carefully collected and recorded. The statistical software SPSS version 23.0 was used to analysed the data. Hence, the level of significance $\alpha = 0.05$.

The following are the statistical techniques that were used:

i. Frequency and percentage analysis was used to describe the background variables of the subjects.
ii. The Range, Mean and Standard deviation was used to describe the quantitative background variable.
iii. The Paired t-test was used to test the significance of pre and post outcome measure of IAT in each group.
iv. The unpaired t-test was used to test the significance of IAT between each group.
v. Chi-square test was used to test the association between the demographic variables and outcome measures.
vi. The tables and graph were generated using MS-WORD, MS-EXCEL and SPSS graphical editor.

RESULTS

Table-1: Description of background variables of amateur soccer players over the groups

Sr. No.	Background variables	Group-A		Group-B		Unpaired t-test	p-value
		Range	Mean ±SD	Range	Mean ±SD		
1.	**Age in years**	18-25	20.39±2.32	18-24	20.50±2.07	t=0.224, NS	p>0.05
2.	**BMI**	19.70-23.93	22.31±.1.17	19.29-24.00	22.46±1.15	t=0.625, NS	p>0.05
3.	**Years of playing**	1-8	4.77±1.81	3-8	5.14±1.67	z=0.714, NS	p>0.05

Note: S- significant, NS-Not significant.

The Table-1 presents the different levels of qualitative variables between the groups which are non-significant, so the values are homogenous. It represents the demographic characteristics of amateur soccer players across two groups (Group A and Group B, each with 36 participants).

The analysis reveals that both groups were well-matched in terms of age (Group A: 20.39±2.32 years, Group B: 20.50±2.07 years,

p>0.05), BMI (Group A: 22.31±1.17, Group B: 22.49±1.15, p>0.05). Years of playing experience also showed no significant difference between groups (Group A: 4.77±1.81 years, Group B: 5.14±1.67 years, p>0.05).

Table-2: Description of qualitative background variables of amateur soccer players over the groups

Sr. No.	Background Variable	Group-A	Group-B	Chi-Square value, df & p-value
		No. & (%)	No. & (%)	
1.	Dominance (m/f)	5(13.9%) / 31(86.1%)	5(13.96%) / 31(86.1%)	0, p>0.05, NS

Note: NS-Not significant. i.e., p>0.05.

Table-2 Examines the dominance patterns between the two groups. The distribution shows similar patterns with 13.9% and 13.9% in one category versus 86.1% and 86.1% in another category for Groups A and B respectively. The chi-square is 0, because both the values are same. It evidences that dominance between both the groups is homogenous and indicates no significant difference in dominance patterns between the groups (p>0.05).

Table-3: Pre and Post-test outcome measure of soccer players in within and between groups

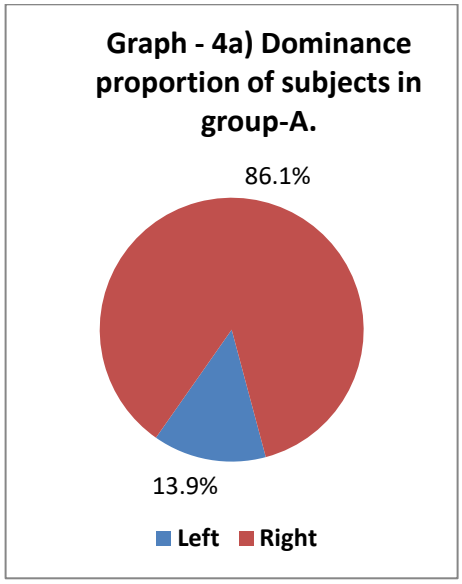
Sr. No.	Group	IAT(Sec)				Paired t-test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	**Group-A**	16.33-23.01	18.83±1.56	15.08-22.68	17.92±1.59	t=12.656, S	p<0.001
2	**Group-B**	16.03-22.51	18.85±1.57	15.30-20.96	17.94±1.42	t=10.475, S	p<0.001
Unpaired t-test		t=0.091, p>0.05, NS		t=0.031, p>0.05, NS			

Note: S-Significant i.e., p<0.05, NS-Not significant i.e., p>0.05.

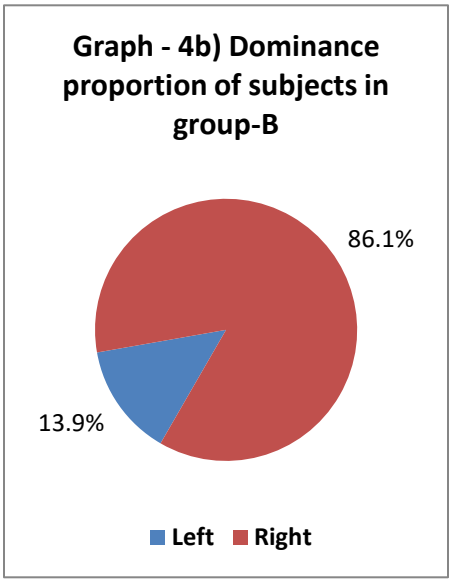
Table-3 Represents the primary outcome measure - the Illinois Agility Test (IAT) results in seconds between the groups. Both groups showed significant improvement from pre-test to post-test. The Paired t-test was found to be significant with value of t=12.656 for Group A. Similarly, for Group B, the paired t-test was significant for Group-B with value of t=10.475. Group A improved from 18.83±1.56 seconds to 17.92±1.59 seconds (p<0.001), while Group B improved from 18.85±1.57 seconds to 17.94±1.42 seconds (p<0.001).

Importantly, there were no significant differences between groups at either pre-test ($p>0.05$) or post-test ($p>0.05$), indicating that both interventions were equally effective.

Both the groups were found to be equally effective for their respective intervention that was measured by Illinois Agility Test (IAT).



GRAPH 1



GRAPH 2

DISCUSSION

The present study was conducted on 72 male amateur soccer players, divided equally into two groups: Group A - receiving core stability training (CST) and Group B – receiving footwork exercises (FWE), over an eight-week intervention period. The study aimed to determine and compare the effects of core stability training (CST) and footwork exercises (FWE) on the agility of amateur soccer players using the Illinois agility test (IAT) as an outcome measure. The Baseline data was collected from both the groups and the results demonstrated significant improvements in agility for both groups, as measured by the Illinois Agility Test (IAT).

The demographic data sample (n=72) shows participants had a mean age of 20.39 with SD of 2.32 in group A, also mean age for group B were 20.50 with SD of 2.07 which is consistent with the findings where amateur soccer players shown to been good agility. According to Pattarapol Thongnum et. al., participants aged between 18-25 showed improvements in agility highlighting the contribution of age-related neuromuscular maturation for agility. [41] Also, the mean BMI of the study participants was 22.31 with a standard deviation of 1.17 in Group-A and 22.46 with a standard deviation of 1.15 in Group-B., This in lines with the study by Muhammad Hidayat et.al., in which they reported that athletes with normal BMI valued between 18-25 is associated with better agility scores, and higher BMI is associated with reduced agility due to increased body load inhibiting muscle's function. [42] Years of playing experience also

showed a noticeable change on performance of IAT during pre- and post-test. Participants had mean of 4.77 with SD of 1.81 in Group-A and mean of 5.14 with SD of 1.67 years. This is in line with previous study by Dr. Kemal goral, which demonstrated that experienced players tend to have good agility scores.[43]

Additionally, experienced players often possess greater familiarity with rapid directional shifts i.e change of directions giving an advantage. According to Mehdi Rouissi et. al., Young soccer players are better at quick changing direction (Agility) when using their stronger, dominant leg compared to their weaker, non-dominant leg. The main reason seems to be that their dominant leg is stronger, helping them perform these moves more effectively. Thereby, in this study there were 86.1% of right dominant players and 13.9% left dominant players in both the groups. [44]

The results demonstrated significant improvements in agility for both groups measured by IAT, with Group A (CST) improving from 18.83 ± 0.56 seconds to 17.92 ± 0.59 seconds ($p<0.01$) and Group B (FWE) improving from 18.85 ± 0.57 seconds to 17.94 ± 0.42 seconds ($p<0.01$). Notably, no significant differences were observed between the groups at pre-test or post-test ($p>0.05$), indicating that both interventions were equally effective in enhancing agility.

A stable core facilitates efficient force transfer between the upper and lower extremities, enabling quicker directional changes and better body control during high-intensity manoeuvres (Savla et al.). [10] This is particularly relevant in soccer, where rapid shifts in movement direction are frequent. Also, footwork exercises including ladder drills and lateral shuffles, directly target lower limb coordination, speed, and reactive ability. These drills mimic the dynamic movements required in soccer, such as dribbling and evading opponents, which explains the agility gains in the FWE group (Gusliandi et al.). [17]

According to previous studies, both CST and FWE are effective in improving athletic performance, especially agility, in a number of sporting events. These results thereby align with the previous studies indicating their importance.

Training for core stability improves the lumbopelvic-hip region's ability to transmit force and maintain balance, which is essential for soccer-specific movements like sprinting and quick direction changes. Sofuoglu et al., demonstrated that an 8-week CST program significantly improved agility in adolescent male football players, as measured by the 505-agility test ($p<0.05$). [3] Also, Chavan and Borkar in 2022, found that a 4-week CST program improved agility in amateur badminton players, evaluated by the IAT ($p<0.05$). [9]

Muhammed Zahit Kahraman and Serkan Kızılca conducted a study that examined the effects of a 4-week core training program on athletic performance in 10–12-year-old female badminton players. They measured speed, agility, strength, and jumping performance before and after the intervention. Results showed significant improvements in agility and jumping performance for the experimental group. However, no significant changes were observed in sprint speed or strength measures. The study concludes that short-term core training can effectively enhance agility ($p = 0.047$) and explosive power ($p = 0.024$) in young badminton players. [45]

Trisnar, demonstrated the effect of 6-week core training on agility in junior boxing

athletes, they used shuttle run test, hexagon agility test, and zig-zag run to test the agility. They concluded that there was increased agility in junior boxers, and also found improvements in stability, coordination, and movement efficiency. [46]

These results are in line with the related studies across soccer, volleyball, hockey, and other team sports, where core training has been shown to enhance balance, agility, and explosive strength, though the magnitude and specificity of these effects can vary depending on the duration, intensity, and design of the training protocol as well as the developmental stage of the athletes.

The literature also refers to the role of core training in injury prevention, improved postural control, and overall movement efficiency, which are critical for both performance optimization and long-term athlete development not only in soccer but in various sports.

The significant improvement in IAT scores for Group A indicates that strengthening core muscles, such as the transverse abdominis, multifidus, and Quadratus lumborum, etc. contributes to better movement efficiency and stability during dynamic tasks and quick change of direction (COD).

Footwork exercises (FWE) including ladder drills and lateral shuffles, target lower-body coordination and reactive speed, mimicking soccer-specific movements like dribbling and evasion. While effective, their impact may be more peripheral, focusing on limb speed rather than whole-body control (Gusliandi et al). [17] It also improves foot speed and coordination, but its impact on overall body control may be limited (Rathod et al., 2023). [15]

Saputra et al. reported that 6 weeks of lateral in-out ladder drills significantly improved agility in U-22 soccer players, which was measured by the zigzag run test ($p<0.05$). [34] Also, Pratama et al. found that ladder drills were more effective than jump rope exercises in enhancing agility among high school athletes ($p<0.05$). [40] Adrian Aritonang and David Siahaan investigated effects of 6-week ladder drills variations on agility of unnamed hockey club athletes, which was measured by zig-zag run test. They concluded that ladder drill had a significant positive effect on agility of unnamed hockey club athletes [t-value = (2.58)]. [35]

Various other studies also have shown similar results in different sports contexts, such as badminton and hockey, where footwork training led to notable gains in agility and balance. Mehak Batool et. al., investigated the effects of 6-week footwork training program on strength and agility in 40 collegiate badminton players, with strength measured via handgrip dynamometer and agility via the Illinois agility test. The experimental group showed significant agility improvement ($p < 0.05$), unlike the control group ($p > 0.05$). This suggests footwork training enhances agility, likely through improved neuromuscular coordination. [16]

The underlying mechanism is likely related to the repetitive, high-speed, multidirectional movements inherent in footwork drills, which improves neuromuscular coordination, proprioception, and the ability to execute rapid direction changes.

The significant improvement in IAT scores for Group B in the present study supports these findings, indicating that FWE enhances footwork precision and movement patterns critical for soccer agility.

The comparative analysis revealed no significant difference between CST and FWE in improving agility among amateur soccer players. Both interventions resulted in comparable reductions in IAT timings, indicating that each method is equally effective for enhancing agility. This is a key finding because it suggests coaches and athletes may select either training mode without compromising agility development, based on personal preferences, available resources, or specific goals for performance.

Both the interventions i.e., CST and FWE target important aspects of agility through different pathways. But yields the similar effectiveness. The main benefits of CST include improved core strength, stability, and balance, which serve as a solid foundation for effective force transfer and limb movement. On the other hand, FWE emphasizes lower limb speed, coordination, and sport-specific movement patterns. In the end, both strategies help players develop better body control and rapid direction changes, both of which are crucial for agility.

The absence of a significant difference between the two interventions ($p>0.05$) aligns with the hypothesis that both CST and FWE are effective for improving agility. Michailidis found that professional soccer players exhibited superior agility compared to amateurs, likely due to structured training regimens. [8]

However, the study's findings challenge the alternate hypothesis, as no superior effect was observed for either intervention. This suggests that coaches, therapists, and trainers can flexibly incorporate either CST or FWE based on resources, player preferences, or training goals without compromising agility outcomes.

Studies comparing different agility training modalities have often found that multiple approaches can yield similar benefits. Chavan and Borkar found that four weeks of CST significantly improved dynamic balance and agility in amateur badminton players ($p< 0.001$).[9] Also, Pratama et al. concluded that both ladder drills and jump rope exercises significantly improved speed and agility in high school athletes, with ladder drills being more effective for agility ($p < 0.05$).[40] This supports the present study's conclusion that both CST and FWE are feasible options for agility training.

CONCLUSION

The present study aimed at investigating the effects of core stability training and footwork exercises on the improvement of agility among amateur soccer players.

However, study demonstrates that both core stability training and footwork exercises are effective in improving agility among amateur soccer players, with no significant difference when compared in between groups. Thereby, enhancing agility through either of the interventions would yield a similar result. Coaches and athletes are encouraged to utilize both CST and FWE as part of comprehensive training programs to enhance agility and overall soccer performance. Future studies should explore optimal combinations of these training interventions to further boost agility training protocols.

Both core stability training and footwork exercises are individually effective training methods for enhancing agility in amateur soccer players, with no significant difference in their effectiveness when compared directly. Hence, Both the interventions were equally effective in improving the agility of the

amateur soccer players. Therefore, the study concludes with the acceptance of null hypothesis which states that there is no significant difference between CST and FWE on agility among amateur soccer players.

Limitations

1. The research did not explore other factors that could influence agility such as lower-body strength.
2. The study lacked biomechanical analysis which could have provided information on specific movement pattern improvements.
3. The study did not monitor the other performance factors like dynamic balance, proprioception, sleep patterns, stress and nutrition.

Future Recommendations

1. Further research may extend the intervention and follow-up periods to assess long-term effects of CST and FWE.
2. Future research may include using multiple agility assessments and incorporating sport-specific performance metrics.
3. Further research may cover the combined effects of CST and FWE or their integration with other training interventions or protocol.
4. Future research should focus on optimizing training protocols for different sports, ages, and competitive levels.

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