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The effects of FIFA11+ warm up program on core endurance, sprint performance and balance in under-21 football players

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Abstract
Introduction: Football is the most played contact- sport around the globe. Due to the nature of the game, a great performance by multiple motor components is required. A good warm-up is required to condition the athletes and prepare them for the complexity of the micro-movements which are happening at neuromuscular level. FIFA 11+ warm-up program serves as the most beneficial protocol to make athletes ready for the competition.
Aim: The aim is to find out the effects of FIFA 11+ on core muscle endurance, sprint performance and balance in under-21 football players.
Methodology: 20 under-21 football players were included in the study. FIFA 11+ protocol was implemented for 4 weeks. Pre and Post Data of McGill core endurance test, 50 m sprint test and stork balance test was recorded.
Statistical analysis: Statistical Analysis is done by appropriate analytical software. As the data was normally distributed, paired-t test was used for within group analysis for each outcome measure respectively.
Results: Significant changes were observed in the pre and post values of core muscle endurance, sprint performance and balance. ($p<0.05$).
Conclusion: It can be concluded that implementing FIFA 11+ program into daily routine will lead to a higher performance which is an essential parameter for optimal performance.

Keywords: FIFA 11+, football players, core endurance, sprint performance, balance

1. Introduction
Football is the most popular sport globally and there is a growing interest for this sport in India. However, the Indian national team is currently ranked 147 of 207 according to the Fédération International de Football Association (FIFA). This ranking suggests that Indian playing standards need to be improved through a focus on the three key areas of physical, technical and tactical skills, as they have been reported to being related to successful football performance [1]. Physiological characteristics that also have been reported as essential for football players are aerobic fitness, agility, core endurance, speed, balance and explosive jumping power [2].
In elite clubs from Union of European Football Associations (UEFA), athletes sustain approximately 28 injuries per 1000 h of exposure in matches; while premier league teams in Asia and South America sustain around 22 and 43 injuries per 1000 playing hours, respectively. They can also adversely affect athletes' health and careers, since approximately 47% of professional football players are forced to leave the sport due to injuries [3].
As an impact collision sport, with injuries occurring in both contact and non-contact situations football is one of the sports with greater potential injuries [4]. It has been demonstrated that the overall risk of injury to professional football players is approximately 1000 times higher than for industrial occupations generally regarded as high risk [5]. The major mechanisms of traumatic football injuries are tackling/being tackled, jumping, landing, turning, falling and collisions with other players/opponents. Running, shooting, turning, overuse, and jumping are the major contributing factors for injury without player to player contact [6]. Sports injury prevention training programs have been reported to be effective in decreasing the incidence of injuries, regardless of sport activity level, sex, and age.

"FIFA11+" is one of the most effective prevention programs, which the Fédération Internationale de Football Association (FIFA) Medical and Assessment Research Center have developed. The FIFA11+ consists of three parts: basic running (part 1); three levels of difficulty of six exercises aiming to increase muscular strength (core and lower limbs), balance, muscle control (plyometrics), and core stability (part 2); and running (e.g. straight-line running or cutting activities) (part 3) [7].

In recent years, some studies reported various improvements in the neuromuscular control and strength of muscles with training using the FIFA11+. A review of the studies reporting on the acute or chronic effects of the FIFA11+ on performance and physiological measures for an intervention period of 9–10 weeks has yielded positive effects. Since its inception, the injury preventative effects of the FIFA11+ have been examined extensively in different football populations. Studies involving adolescent and young adults consistently reported a reduction in lower extremity injuries with regular program use, with a recent systematic review reporting an overall noncontact injury reduction of 30%. Over the last decade, researchers have also been studying the short- and long-term effects the FIFA11+ on various physical performance metrics (PMs) in different populations [8].

Performance in football often occurs on relatively unstable surfaces (e.g., jumping and landing on uneven natural turf, kicking a ball while being impeded by an opponent) and the challenge to the balance of the players is more compared to other sporting games [9]. This is suggestive that football players require more dynamic balance compared to other games. Balance during sports activities requires proper neuromuscular control, which is a unique integration of inputs from the periphery into the central nervous system and back, with the aim of maintaining the posture in non-constant, external environment [10]. Sprint performance in football players is determined by a rapid increase in acceleration (through 18.3 m) and a high velocity maintained throughout the sprint and is independent of position played. The best sprint performances (independent of sprint distance) appear to be related to the highest initial acceleration (through 18.3 m) and highest attained and maintained velocity [11]. However the effect of FIFA11+ program on core endurance, balance and sprint performance still remains unclear. Thus the aim of our study was to investigate the effect of FIFA11+ program on core endurance, balance and sprint performance after 4 weeks of performance.

2. Method

An experimental study was conducted at the Sports Authority of Gujarat (SAG) Football Academy for 1 month. Intervention was given for 4 weeks; 6 training sessions were conducted. The sample size was 10 in each group. Hence, 20 subjects were included in the present study using convenience sampling. Football players under 21 years were included in the study. Players with any history of recent surgery (4-6 months), musculoskeletal and joint injuries, who have participated in other sports simultaneously, or have missed over 10% of training sessions and not willing to participate were excluded. Mats, Cones, Bench, Straps were used in the study. Outcome Measures used were the 50 m sprint test, McGill's Core Endurance Tests and the Stork Balance test.

50 m sprint test involves running a single maximum sprint over 50 meters, with the time recorded. A thorough warm up should be given, including some practice starts and accelerations. Start from a stationary standing position (hands cannot touch the ground), with one foot in front of the other. The front foot must be behind the starting line. Once the subject is ready and motionless, the starter gives the instructions "set" then "go". The tester should provide hints for maximizing speed (such as keeping low, driving hard with the arms and legs) and the participant should be encouraged to not slow down before crossing the finish line [12].

Core Muscle Endurance was measured using the McGill's Core Endurance Tests. These tests consisted of four tests: the trunk anterior flexor test, the right and left lateral plank, and trunk posterior extensor test. Participants performed one practice trial. The maximum time (seconds) participants could hold a static position in each position was measured [13].

Lateral Bridge Test (Bilateral): Legs are extended and the top foot is placed in front of the lower foot for support. Athlete supports themselves on one elbow and on their feet while lifting their hips off the floor to create a straight line over their body length. The uninvolved arm is held across the chest with the hand placed on the opposite shoulder. (Figure 1)

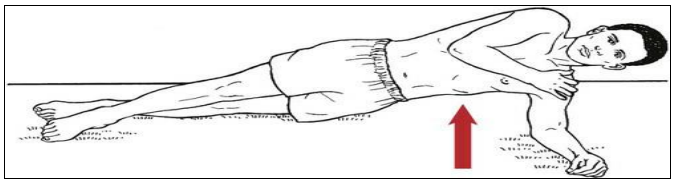

Fig 1: Lateral Bridge Test

Flexor Endurance Test: The athlete sits at 60 degrees with both hips and knees at 90 degrees, arms folded across the chest with hands placed on the opposite shoulder, and toes secured under toe straps or by the examiner. (Figure 2)

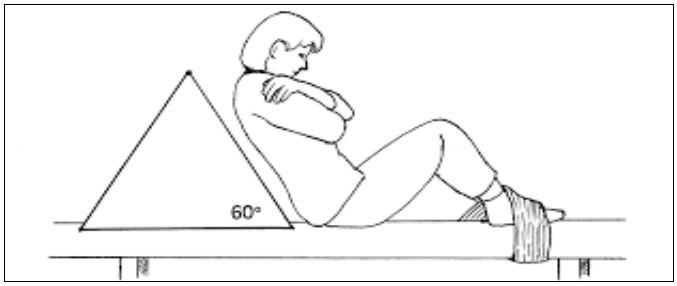

Fig 2: Flexor Endurance Test

Extensor Endurance Test: The athlete is prone over the edge of the table with the pelvis, hips and knees secured. The upper limbs are held across the chest with the hands resting on the opposite shoulders. (Figure 3).

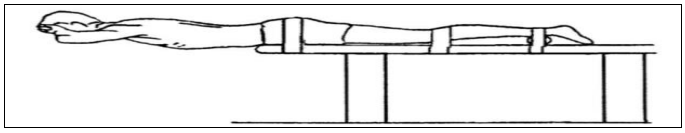

Fig 3: Extensor Endurance Test

Balance performance (BPf) of the participants was assessed with the Stork balance stand test. This test measures the ability of the participant to balance on the ball of the foot with hands placed on the hips while positioning the non-supporting foot against the inside knee of the supporting leg. Using a stopwatch, the amount of time in seconds that the participant is able to stand on the ball of the foot of one leg is indicative of his BPf. The timing is stopped if the supporting foot swivels or moves (hops) in any direction or the non-

supporting foot lose contact with the knee or the heel of the supporting foot touching the floor. For each participant, the overall score was the best of three attempts. The same procedure was carried out for both lower limbs [14]. The procedure is shown in flowchart figure 4.

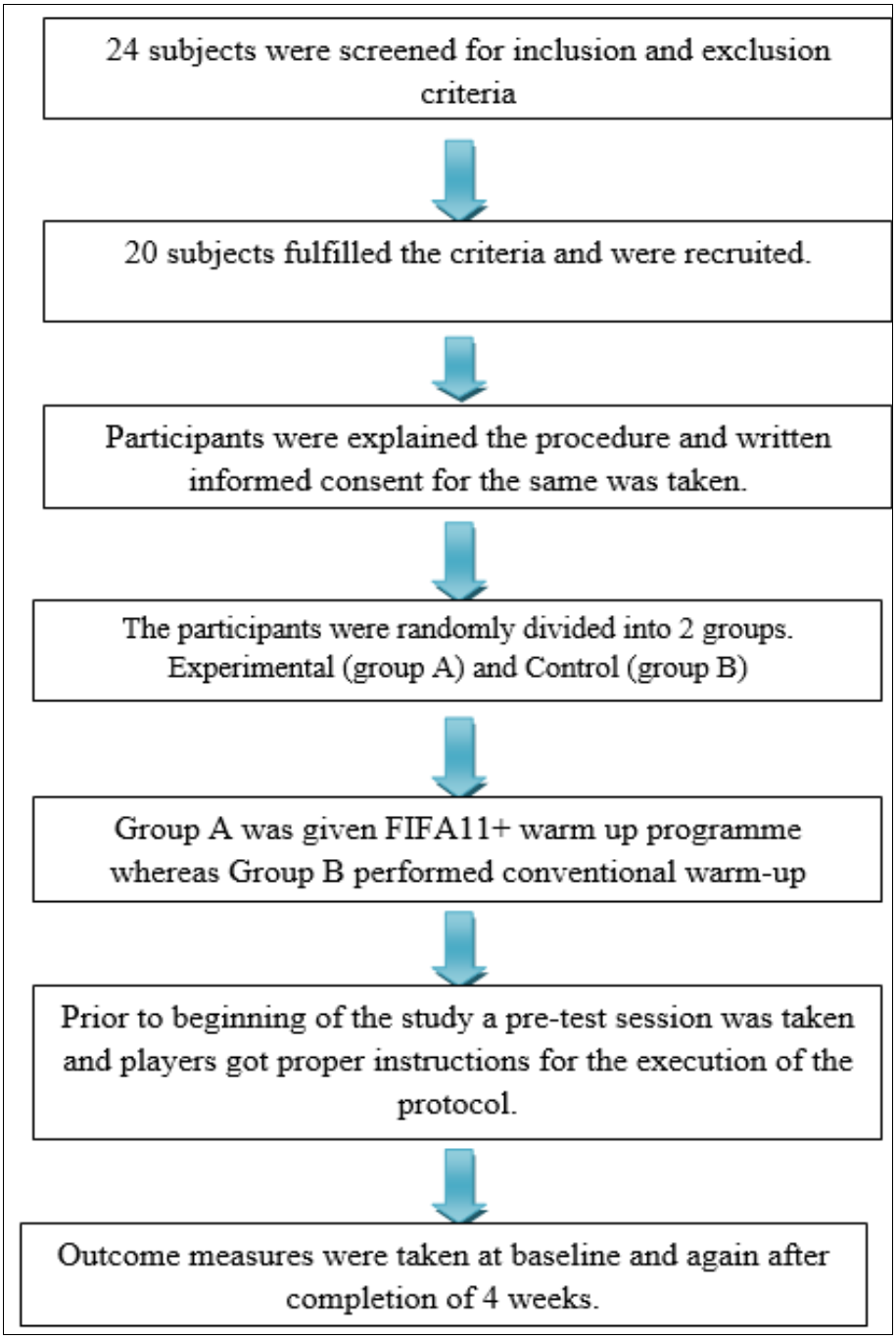

Fig 4: Flowchart of procedure

3. Statistical Analysis

Data was analyzed using SPSS version 20 and Microsoft Excel 2010. Level of significance was kept at 5%. Appropriate statistical tests were applied to compare differences within groups and between groups. The data was normally distributed so parametric tests were used. The data is presented in graphs and tables.

4. Result

The demographic data of both the groups are presented in table 1. There was no statistically significant difference between group A and group B in terms of height, weight, age and BMI

Table 1: Demographic data of group A and group B

Characteristic (Mean ± SD)	Group A	Group B	p-value
Age (years)	20.3± 1.75	20.1± 1.83	0.400
Height (cm)	173.7 ± 1.79	174.6 ± 2.63	0.148
Weight (kg)	56.51 ±1.34	57.74± 2.29	0.329
B.M.I (kg/m^2)	19.69± 0.89	20.57±1.25	0.445

The baseline parameters of the both groups are presented in Table 2. Players in both groups were generally well matched at baseline as no significant differences were noted in all baseline variables (p> 0.05).

Table 2: Baseline characteristics of both groups

Variables (Mean ± SD) (in sec)	Group A (Experimental)	Group B (Control)	t-value	p-value	Significant
50 m sprint test	6.98 ± 0.60	7.24 ± 0.36	1.48	0.15	No
Flexor Endurance Test	157.56 ± 6.19	158.92± 11.14	0.05	0.95	No
Extensor Endurance Test	93.74±6.8	91.68± 6.57	0.69	0.49	No
Right Side Lateral Bridge Test	85.53±3.25	83.63±5.24	1.06	0.30	No
Left Side Lateral Bridge Test	85.548±4	83.50±5.97	1.03	0.32	No
Stork Balance Test Right Side	44.22±5.79	41.95 ±6.58	0.69	0.49	No
Stork Balance Test Left Side	45.84± 4.59	42.61±6.7	0.71	0.84	No

Within group analysis was done using paired t test within the intervention group and the control group. There was statistically significant difference found for all the outcomes in group A (p<0.05), whereas for control group only stork balance test had statistically significant difference (p<0.05). This is shown in table 3 and table 4.

Table 3: Within group comparison in experimental group A

Outcome measures	Pre-post	Group A (Mean ± SD)	t-value	p-value	Significance
50 m sprint test	Pre	6.98±0.6	4.213	0.002	Yes
	Post	6.69±6.6			
Flexor Endurance Test	Pre	157.5±6.1	4.70	0.001	Yes
	Post	165.5±5.8			
Extensor Endurance Test	Pre	93.7±6.8	5.18	0.0006	Yes
	Post	107.5±1.04			
Right Side Lateral Bridge Test	Pre	85.5±3.25	4.6	0.001	Yes
	Post	88.8±3.62			
Left Side Lateral Bridge Test	Pre	85.5±4.0	6.34	0.0001	Yes
	Post	89.6±4.5			
Right Stork Balance Test	Pre	44.2±5.79	3.62	0.005	Yes
	Post	45.8±4.5			
Left Stork Balance Test	Pre	45.8±4.5	3.98	0.003	Yes
	Post	47.21±3.88			

Table 4: Within group comparison in control group B

Outcome measures	Pre-post	Group B (Mean ± SD)	t-value	p-value	Significance
50 m sprint test	Pre	7.24±0.36	2.14	0.06	No
	Post	7.11±0.28			
Flexor Endurance Test	Pre	158.91±11.14	1.19	0.2	No
	Post	159.04±13.34			
Extensor Endurance Test	Pre	91.67±6.57	1.35	0.2	No
	Post	92.06±6.89			
Right Side Lateral Bridge Test	Pre	83.63±5.24	1.5	0.16	No
	Post	84.05±5.4			
Left Side Lateral Bridge Test	Pre	83.5±5.97	1.75	0.11	No
	Post	83.8±6.35			
Right Stork Balance Test	Pre	41.95±6.5	2.38	0.04	Yes
	Post	43.9±5.96			
Left Stork Balance Test	Pre	42.61±6.71	3.03	0.01	Yes
	Post	44.15±6.88			

Between group analysis was done by unpaired t test and statistically significant difference was found in 50 m sprint test, extensor endurance test, rt. and lt. lateral bridge test and lt. stork balance test (p<0.05). There was no statistically significant difference found between experimental group and control group in flexor endurance test and rt. stork balance test (p>0.05). This is shown in table 5.

Table 5: Between group analysis with unpaired t test

Outcome measure	Group	Mean ±SD	t-value	p-value
50 m sprint test	Control group	7.11±0.288	4.23	0.02
	Experimental group	6.69±0.47		
Flexor Endurance Test	Control group	159.04±13.32	1.87	0.17
	Experimental group	165.55±5.87		
Extensor Endurance Test	Control group	92.06±6.89	1.21	0.001
	Experimental group	107.01±10.4		
Right Side Lateral Bridge Test	Control group	84.05±5.4	3.4	0.03
	Experimental group	88.85±3.62		
Left Side Lateral Bridge Test	Control group	83.87±6.35	1.75	0.04

	Experimental group	88.85±3.55		
Right Stork Balance Test	Control group	43.9±5.96	2.79	0.42
	Experimental group	45.84±4.59		
Left Stork Balance Test	Control group	44.15±6.88	4.1	0.02
	Experimental group	47.2±3.88		

5. Discussion

The present study was designed to find out the effects of FIFA 11+ warm up programme on sprint performance, core muscle endurance and balance in male under-21 football players. A pre-test/ post-test design was implemented over a period of four weeks. 50 m sprint test was used for assessing sprint performance and the McGill core endurance test (i.e.: Flexor endurance test, Extensor endurance test, Right and Left Lateral Bridge Test) was used to assess core muscle endurance and stork balance test for balance. After four weeks re-evaluation of all outcome measures was being carried out.

Results of the present study have shown that there is statistically significant improvement in the experimental group in terms of sprint, core muscle endurance and balance. There was no statistically significant improvement in the control group. Between group analysis showed significant improvement in all the outcome measures ($p<0.05$).

P. Anderson *et al*. (2014) [15] studied the effects of Warm-up (WUP) on intermittent sprint performance [15]. Eleven male, team-sport players performed four trials in a randomized, cross-over design, consisting of an intermittent-sprint protocol (15 × 20-m sprints) that followed either no-WUP or one of three 10-min WUP trials that varied in intensity. The 3 Warm-ups varied according to the lactate and anaerobic threshold. Sprint times were fastest following WUP 3. These findings are consistent with the findings obtained in present study for improvement in sprint performance ($p< 0.05$).

Mostafa Zarel *et al*. (2018) [16] examined the long-term effects of the 11+ on physical performance in adolescent male football (soccer) players [16]. Eighty-two under 16 year-old male football players participated. Teams were randomized to control (CON) and intervention (INT) groups. INT applied the 11+ injury prevention programme for 30 weeks at least twice a week as a warm-up. CON performed their standard warm-up and improvement was observed in favor of INT in the 9.1 m sprint test along with other performance parameters. The findings are similar with the present study in terms of improvement in sprint performance. The reason why this finding is similar to that of the present study can be because that the players in this article were in their developmental age and were subjected to perform the intervention for 30 weeks whereas in the present study the subjects were in a mature age of under 21 and as they are elite athletes the similar result was achieved in 4 weeks when subjected to 6 training sessions per week.

Thomas Renner *et al*. (2008) examined the relationship between core stability and performance in division 1 football players. Subjects were tested on three strength variables (one-repetition maximum [1RM] bench press, 1RM squat, and 1RM power clean), four performance variables (countermovement vertical jump [CMJ], 20- and 40-yd sprints, and a 10-yd shuttle run), and core stability (back extension, trunk flexion, and left and right bridge). Significant correlations were identified between total core strength and other performance parameters such as shuttle run, 20 yard sprint, 1 RM, power clean etc. The purpose of this study was to identify relationships between core stability and various strength and power variables in strength and power athletes [17]. The results of this study suggest that core stability is moderately related to strength and performance which is in contrast to the present study which concludes that incorporating FIFA 11+ warm up programme which includes exercises involving the core improves the other performance variables such as 50 m sprint, balance as well as core endurance.

Jose Francisco *et al*. (2014) did a systematic review on the impact of the FIFA 11+ training program on injury prevention in football players [18]. The FIFA 11+ has demonstrated how a simple exercise program completed as part of warm-up can decrease the incidence of injuries in football players. In general, considerable reductions in the number of injured players, ranging between 30% and 70%, have been observed among the teams that implemented the FIFA 11+. In addition, players with high compliance to the FIFA 11+ program had an estimated risk reduction of all injuries by 35% and show significant improvements in components of neuromuscular and motor performance when participating in structured warm-up sessions at least 1.5 times/week which supports the findings of our study where FIFA 11+ warm up was delivered in 6 sessions per week. So, successful implementation of this protocol does not only help in injury prevention but also improves the motor performance.

Hanna Lindblom *et al*. (2012) [19] performed a randomised controlled trial to see effect on performance tests from a neuromuscular warm-up programme in youth female football. Four youth female football teams with players of under-16 age group were randomised into an intervention group and control group. The intervention was a 15-minute neuromuscular warm-up program carried out twice a week during the 11-week study period. Baseline and follow-up measurements of performance were made indoors and included the star excursion balance test, a countermovement jump test, a triple-hop for distance test, a modified Illinois agility test, and 10 and 20 m sprint tests. Insignifanct results were obtained which showed no improvement in the outcome measures post the 11 week compliance of the protocol apart from agility and balance which is consistent with the present study in terms of balance and non-consistent in terms of sprint test respectively. This older study is in contrast to present finding.

The improvement seen with FIFA 11+ could be explained by better stabilization, muscle strength, proprioceptive and postural alignment. It is theorized that a strong core allows an individual the full transfer of forces generated from the ground through the lower extremities, the torso, and finally to the upper extremities. A weak core is believed to cause alterations in the transfer of energy, resulting in reduced sport performance and risk of injury to a weak or underdeveloped muscle group [20].

6. Conclusion

The present study concluded that compared to conventional warm up programme, FIFA 11+ has more significant effect in terms of sprint, core muscle endurance and balance, making it a better exercise programme to prevent injury as well as to enhance the performance of football players.

More efforts should be made to incorporate FIFA11+ warm up programme in routine schedule of footballers and

awareness should be made regarding the same.

7. Limitations of the Study

Long term follow up was not taken in the present study. Moreover motor components can be assessed in the future study.

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