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Original Article

Physiotherapy Section

Effect of FIFA 11+, Dynamic and Regular Warm-up Protocols on Speed, Agility, and Lower Limb Explosive Power in Badminton Players: A Quasi-experimental Study

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ABSTRACT

Introduction: FIFA 11+ (Federation International Le De Football Association), has already shown a positive response to the various physical parameters and reduced injury rates in football players, similar studies were not performed on badminton players. With this background, the present study was conducted.

Aim: To compare the effects of FIFA 11+, dynamic warm-up, and regular badminton warm-up on speed, agility, and lower limb explosive power.

Materials and Methods: A quasi-experimental study was conducted in different badminton academies located in Faridabad, Haryana, India, from September 2017 to March 2019 with the implementation of the programme for four weeks with a sample size of 48 players (both male and female) aged between 14-18 years participated in the study. The participants were divided randomly into group A; following FIFA 11+ protocol (11+ is a multifaceted warm-up program with four components- sprinting, strength, plyometric and balance), group B followed dynamic warm-up and group C followed their regular warm-up. The players followed the protocols for four weeks (12 sessions with FIFA 11+ for 15-20 minutes and dynamic warm-up of 15 minutes). A pre and postassessment was done for agility using a T-test, speed was assessed by a 10 m sprint, and Lower limb explosive power was assessed using the vertical jump test. The statistical tests used for analysis was the Post-Hoc Tukey test for between-group analysis and Analysis of Variance (ANOVA) paired t-test for within-group analysis using Statistical Package for Social Sciences (SPSS) version 21.0 software.

Results: There was no statistical difference between the three groups when the Post-Hoc Tukey test was done. However, when within the group analysis was done using paired t-test there was statistically significant difference for agility in group A (p-value=0.030) and speed in group B (p-value=0.021).

Conclusion: This study concludes that none of the three groups out performed the other for all the parameters.

Keywords: Badminton, Performance, Prevention protocol, Sensorimotor training

INTRODUCTION

Since 1992, badminton is an Olympic sport and is one of the most widely played sports across the globe [1,2]. Badminton demands a high level of technical and mental prowess, apart from cardiovascular endurance, good strength in muscles, speed, and agility are required [3]. Along with it, flexibility and explosive strength are perineal [2]. At an elite level, badminton requires the involvement of a combination of aerobic and anaerobic systems, which depends on the duration of the game [3]. Warm-up is done prior to physical activity, to prepare the body for both physical and psychological aspects. The warm-up aims at improving both static and dynamic balance, neuromuscular coordination, and proprioception of joints along with improved flexibility [4,5].

Dynamic stretching has been attributed in improving neuromuscular coordination, thus, improving athletic performance and prevents injury [6]. In addition, it improves agility, sprint speed, and power, all being valuable performance determinants [7-10]. A study has revealed that it is also associated with improved oxygen uptake, and reduced values of blood lactate and blood pH [11]. FIFA Medical Assessment and Research Centre created FIFA 11+ warm-up programme (F-MARC) with the chief goal being the prevention of the most regular football injuries by targeting cardiovascular and neuromuscular systems [12]. An 11+ is a multifaceted warm-up programme with four components (sprinting, strength, plyometrics, and balance) performed to increase the physical fitness of the footballers [13].

Study have reported a decrease in soccer injury by 30-70%; being about 50% in adolescent footballers including both genders. Also, substantial injury declination has been reported in elite basketball when 11+ programme was utilised [14]. FIFA 11+ is reported to be beneficial in comparison to conventional dynamic warm-up in the prevention of injuries to the lower level [15].

Although FIFA 11+, is a tailored programme used in football, which has already been shown to produce a positive response to the various physical parameters and reduce injury rates in football players, such studies were not performed in Badminton players. With this motive, the present study was conducted with an aim to compare the effects of (Federation International Le De Football Association) FIFA 11, dynamic warm-up and regular badminton warm-up on speed, agility, and lower limb explosive power in badminton players.

MATERIALS AND METHODS

A quasi-experimental study was conducted in different badminton academies located in Faridabad, Haryana, India, from September 2017 to March 2019 with the implementation of the programme for four weeks with a sample size of 48 players (both male and female) collected using the G-Power method. Ethical clearance was obtained (MRIIRS/FAHS/2017/166).

Inclusion and Exclusion criteria: Age being 14-18 years', both male and female, with a minimum of 6 months of experience in playing badminton, with participation at school or district/state level championships. Exclusion criteria included any musculoskeletal

injury/pain, any cardiovascular disorder, fracture, or ligament injury within six months, or any upper/lower extremity deformity.

Study Procedure

After attaining consent forms signed by the parent/coaches, the player's height, weight, and Body Mass Index (BMI) were taken prior to the session. Height was measured in centimetres by means of a stadiometer, weight was measured in kilograms by means of a digital weighing machine, and BMI was calculated in kg/m^2. After the measurements were taken, the players were made to do a warm-up for five minutes which involved jogging and dynamic stretching. After that, the participants were given detail about the different tests which were to be performed. The first test includes a speed test which was taken for a 10 m distance and measured with a stopwatch in seconds, the second test includes a t-test for agility, measured with a stopwatch in seconds, and the third test was a vertical jump test (sargent jump test) for lower limb explosive power, measured in centimetre.

After the test was completed, the players were conveniently assigned into 3 groups (with 16 players in each group):

- Group A to follow FIFA 11+ warm-up
- Group B to follow the dynamic warm-up
- Group C who were kept in a controlled group followed their regular warm-up routine.

The participants were assessed again post four weeks of the warm-up programme. All the groups received similar training for badminton other than the warm-up being provided.

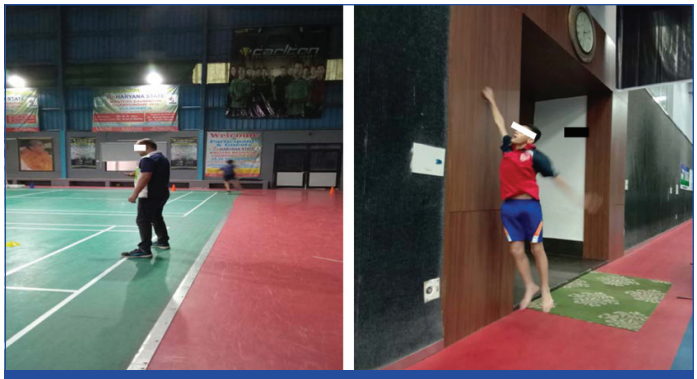
A 10 m speed test: Time for a 10 m sprint in a straight track was measured by using a stopwatch. Each sprint was started from an individually selected standing position. Each player completed 3 trials of 10 m sprints spread over 60 seconds of the recovery period, and the mean of the three sprints was taken [16].

T-test agility test: Three cones (B, C, and D) were placed within 5 yards (4.57 m) distance between cone B to cone C and cone B to cone D, respectively and the fourth cone A was placed at a distance of 10 yards (9.14 m) from cone B. Players began with both their feet behind the starting point A. Each player ran forward 9.14 m (10 yards) on the go signal to point B and tapped the cone with the right hand. They then shuffled to the left direction; 4.57 m (5 yards) and tapped cone C with their left hand. Players then shuffled to the right at 9.14 m and tapped cone D with the right hand. They then shuffled to the left 4.57 m back to point B and tapped the cone with their left hand. The player then ran backward, passing the finishing line at point A [Table/Fig-1]. A one minute gap between the trials was given for recovery. Three test trials were completed, and time was recorded using stopwatch in seconds. The means of the trials were used for statistical analyses [17].

Vertical jump test: The athlete stands on the side of a wall and reaches up with the hand nearest to the wall, with feet flat on the floor and then marks the point with the chalk. This is termed as the standing reach height. The athlete then stands aside from the wall and jumps vertically as high as possible using both arms and legs to help in projecting the body upwards and tries to make a mark on the wall at the highest point of the jump. The difference in distance between the standing reach height and the jump height is the score [Table/Fig-2]. A 45 seconds to one minute of the gap is given in between each trial and the best of three attempts is recorded. The distance is measured in centimetres [18].

Interventions

FIFA 11+: The FIFA 11+ involves the exercises in three parts [Table/Fig-3], the first part of the programme includes six running exercises [19]. The next part includes six exercises in part two for strength, balance, and plyometrics, all of which include three different levels of difficulty from beginners to advanced. The third part contains three



[Table/Fig-1]: Subject performing t-test.
[Table/Fig-2]: Vertical jump. (Images from left to right)

advanced running exercises. All the applicants in group A followed the FIFA 11+ warm-up level 1 (beginners) for four weeks. The 11+, which substituted the normal warm-up training, took about 15-20 minutes to finish. Entire exercises determined the stability of the core, eccentric hamstring strength, neuromuscular control, and agility.

Set-up for exercise [Table/Fig-4]: Six pairs of cones were used and placed parallel to each other with about a five to six-metre distance between the cones. Two athletes begin together from the starting point of the cones and jog and perform different exercises beside and inside the cones and then run along from the outside while returning from the last cones.

Exercise	Duration
Part 1: Running exercises	8 minutes
1. Straight ahead	2 sets over 30 m each exercise
2. Hip out	2 sets over 30 m each exercise
3. Hip in	2 sets over 30 m each exercise
4. Circling partner	2 sets over 30 m each exercise
5. Shoulder contact [Table/Fig-5]	2 sets over 30 m each exercise
6. Quick forward and backwards	2 sets over 30 m each exercise
Part 2: Strength-Plyometric-Balance	10 minutes
7. The bench: Static	3 sets×30 s
8. Sideways bench: Static	3 sets×20 s
9. Hamstrings: Beginner	1 set×5 repetitions
10. Single-leg stance: Hold the ball	2 sets×30 s each leg
11. Squats: With toe raise	2 sets×30 s
12. Jumping: Vertical jumps	2 sets×30 s
Part 3: Running exercises	2 minutes
13. Across the pitch	2 sets×30 m (70-80% maximum pace)
14. Bounding	2 sets×30 m
15. Plant and cut	2 sets×5 repetitions (80-90% maximum pace)

[Table/Fig-3]: FIFA 11+ warm-up programme [19].

[Table/Fig-4]: FIFA 11+ warm up set up.
[Table/Fig-5]: Shoulder contact. (Images from left to right)

Dynamic warm up: The dynamic warm-up programme was selected from the study done on badminton players by Magner A et al., [10]. Athletes from group B followed the dynamic warm-up programme

for four weeks period. Stretching procedures were explained for the dynamic protocol to the athletes. The duration of the dynamic warm-up procedure was 15 minutes. The stretching was performed by the players according to their individual points of discomfort and limits [10] [Table/Fig-6,7].

Dynamic stretch/warm-ups	
Enclosed room length of 44 feet	
Order performed:	
Jog	Down and back 4x
Backpedal	
Jog down	Backpedal back
Skipping	Down and back 4x
High knees	Down and back 4x
Butt kicks [Table/Fig-8]	Down and back
High knees down	Butt kicks back
Skipping	Down and back 4x
Carioca	Down and back 4x (also known as grapevine)
Walking sumo squats	Down and back
Defensive slides	Down and back
Frankenstein walks	Down and back
Heel walks/toe walks	Down and back respectively- 4x
Wall-assisted leg throws- facing wall	10 right leg
Wall-assisted leg throws- side to the wall	10 right leg
Frankenstein- keeping legs straight swing one at a time high up in front with your hands stretched out and chest high	10 right leg

[Table/Fig-6]: Dynamic warm-up.

[Table/Fig-7]: Dynamic warm up set-up.
[Table/Fig-8]: Butt kicks. (Images from left to right)

STATISTICAL ANALYSIS

Statistical analysis was performed with the help of Statistical Package for Social Sciences (SPSS) version 21.0. All the groups were analysed for within-group differences for the various variables by means of a paired-samples t-test with a significance level set at 0.05. For between the group analysis the groups were analysed using Tukey's Post-Hoc Analysis with the level of significance set at 0.05.

RESULTS

The mean age of the participants in group A was 14.56±0.70 years and nine males and seven females [Table/Fig-9].

The mean of prespeed in FIFA 11+, dynamic stretching, control group was 2.45±0.22, 2.41±0.11 and 2.44±0.21, respectively [Table/Fig-10].

In group A (FIFA 11+) there was statistically significant improvement seen in agility with p-value 0.03. In group B (dynamic stretching) there was statistical significance in speed with p=0.02 [Table/Fig-11].

The result of the post-hoc analysis shows that there was no significant difference between the groups [Table/Fig-12].

Group	Male: Female population ratio in each group out of 16	Age (in years) Mean±SD	Height (in cm) Mean±SD	Weight (in kg) Mean±SD	BMI (kg/m^2) Mean±SD
Group A (FIFA 11+)	9 Male: 7 Female	14.56±0.70	163.28±6.37	53.74±7.62	20.06±1.81
Group B (Dynamic)	12 Male: 4 Female	14.25±0.43	159.40±9.75	49.12±7.97	19.29±2.32
Group C (Control)	11 Male: 5 Female	15.31±1.21	164.88±8.73	54.50±4.66	20.09±1.65

[Table/Fig-9]: Anthropometric characteristics of all group.

Parameters		Mean±SD
Prespeed	FIFA 11+	2.45±0.22
	Dynamic stretching	2.41±0.11
	Control group	2.44±0.21
	Total	2.43±0.18
Postspeed	FIFA 11+	2.42±0.15
	Dynamic stretching	2.50±0.14
	Control group	2.47±0.25
	Total	2.46±0.19
Preagility	FIFA 11+	12.48±0.86
	Dynamic stretching	12.11±1.30
	Control group	12.46±1.43
	Total	12.35±1.21
Postagility	FIFA 11+	12.26±1.00
	Dynamic stretching	12.32±0.85
	Control group	12.58±1.50
	Total	12.39±1.13
Prevertical jump	FIFA 11+	35.17±7.30
	Dynamic stretching	35.64±5.38
	Control group	42.16±11.28
	Total	37.66±8.79
Postvertical jump	FIFA 11+	37.25±6.92
	Dynamic stretching	35.18±6.22
	Control group	40.85±10.85
	Total	37.76±8.41

[Table/Fig-10]: Table showing descriptive statistics.

Group			t	df	Sig. (2-tailed)
Group A (FIFA 11+)	Pair 1	Prespeed- Postspeed	0.64	15.00	0.53
	Pair 2	Preagility- Postagility	2.39	15.00	0.03
	Pair 3	Preverticaljump- Postverticaljump	-1.92	15.00	0.07
Group B (Dynamic stretching)	Pair 1	Prespeed- Postspeed	-2.59	15.00	0.02
	Pair 2	Preagility- Postagility	-1.02	15.00	0.32
	Pair 3	Preverticaljump- Postverticaljump	0.38	15.00	0.71
Group C (Control group)	Pair 1	Prespeed- Postspeed	-0.90	15.00	0.38
	Pair 2	Preagility- Postagility	-1.03	15.00	0.32
	Pair 3	Preverticaljump- Postverticaljump	1.89	15.00	0.08

[Table/Fig-11]: Paired samples t-test for within group analysis.

DISCUSSION

Though the findings of the study revealed no statistically significant difference between all three groups of the study. However, it was observed that there was an improvement in agility among the group of FIFA 11+ and speed in the dynamic group with statistical significance when the within-group analysis was done. The results of this study are supported by the results of the following studies.

Dependent variable			Mean difference (I-J)	Standard error	p-value
Prespeed	FIFA 11+	Dynamic stretching	0.03625	0.06800	0.856
		Control group	0.01000	0.06800	0.988
	Dynamic stretching	FIFA 11+	-0.03625	0.06800	0.856
		Control group	-0.02625	0.06800	0.921
	Control group	FIFA 11+	-0.01000	0.06800	0.988
		Dynamic stretching	0.02625	0.06800	0.921
Postspeed	FIFA 11+	Dynamic stretching	-0.07938	0.06846	0.483
		Control group	-0.04625	0.06846	0.779
	Dynamic stretching	FIFA 11+	0.07938	0.06846	0.483
		Control group	0.03313	0.06846	0.879
	Control group	FIFA 11+	0.04625	0.06846	0.779
		Dynamic stretching	-0.03313	0.06846	0.879
Preagility	FIFA 11+	Dynamic stretching	0.37125	0.43341	0.670
		Control group	0.02062	0.43341	0.999
	Dynamic stretching	FIFA 11+	-0.37125	0.43341	0.670
		Control group	-0.35063	0.43341	0.699
	Control group	FIFA 11+	-0.02062	0.43341	0.999
		Dynamic stretching	0.35063	0.43341	0.699
Postagility	FIFA 11+	Dynamic stretching	-0.05687	0.40761	0.989
		Control group	-0.31375	0.40761	0.723
	Dynamic stretching	FIFA 11+	0.05687	0.40761	0.989
		Control group	-0.25688	0.40761	0.804
	Control group	FIFA 11+	0.31375	0.40761	0.723
		Dynamic stretching	0.25688	0.40761	0.804
Prevertical jump	FIFA 11+	Dynamic stretching	-0.46875	2.95616	0.986
		Control group	-6.98750	2.95616	0.057
	Dynamic stretching	FIFA 11+	0.46875	2.95616	0.986
		Control group	-6.51875	2.95616	0.081
	Control group	FIFA 11+	6.98750	2.95616	0.057
		Dynamic stretching	6.51875	2.95616	0.081
Postvertical jump	FIFA 11+	Dynamic stretching	2.06250	2.91921	0.761
		Control group	-3.60625	2.91921	0.439
	Dynamic stretching	FIFA 11+	-2.06250	2.91921	0.761
		Control group	-5.66875	2.91921	0.139
	Control group	FIFA 11+	3.60625	2.91921	0.439
		Dynamic stretching	5.66875	2.91921	0.139

[Table/Fig-12]: Tukey HSD. (I-J) mean difference between first component to the second (e.g., Fifa 11+ to dynamic stretching, Fifa 11+ to control group, etc.).

A study by Impellizeri F et al., on physiological and performance responses to the FIFA 11+, found no substantial differences in agility and sprint, and vertical jump and extensor strength [20]. Also, a study by Steffen K et al., 2008, reported no significant performance differences in any of the variables (like strength, vertical jump, sprint and soccer skill tests) between the intervention group (using the FIFA 11 programme) against the control group [21]. The possible reason for the results is that the FIFA 11+ might not have been rigorous enough to provide adequate physiological stimulus to reach the desired training effects [20,21].

The results of the present study were contrary to the results of Gee TI et al., where the use of modified FIFA 11+ protocol on female court-sport athletes gave an effective response by enhancing dynamic neuromuscular control and sport-specific physical performance [22]. A study also showed effective improvement in female badminton athletes' performance ability, in preventing sports injury and improving limb asymmetry by implementing integrative neuromuscular training [5]. Lu Z et al., found significant improvement in the use of combined balance and plyometric training on dynamic balance in elite badminton athletes [23]. Ganeshkumar T and Senthilkumar PK, when implemented neuromuscular training and specific skills training in school-level badminton players found a significant influence on speed and leg explosive power [24].

Dynamic stretching protocols had no significant time, condition, and interaction effects over the 10-m sprint time when analysed for the effect of warm-ups incorporating different volumes of dynamic stretching in highly trained male soccer athletes. The results may be due to incorrect technique of the subjects to have the ability to efficiently accelerate in comparison to experienced sprinters [25]. Dynamic stretching neither had improvement nor did it hamper performance when applied alone or in combination with static stretching in a study done to analyse the effects of warm-ups involving static or dynamic stretching on agility, sprinting, and jumping performance in trained individuals [7]. Static form of stretching when involved with a dynamic form of warm-up impeded sprint performance in collegial athletes. This could be the reason for FIFA 11+ not reporting any improvement in the parameter of speed [26].

Stretching considerably impedes the 20 m time performance. The study showed that both forms of stretching showed no change or influence for both boys or girls in terms of 20 m performance. Dynamic stretching acutely decreased counter movement jump performance by 2.2% in both genders. In common, flexibility values were enhanced after no stretching (5.2%), static stretching (12.1%), and dynamic stretching (6.5%) both in young boys and girls. Dynamic stretching formed less variations in CMJ and sit and reach than static stretching [6]. No noticeable alteration was witnessed in the peak jump height during jump performance for up to five minutes after both the stretching procedures in a group of female volleyball athletes [5]. Also, the jump performance of female basketball athletes was unchanged by either of the two stretching protocols when the jumps were accomplished four minutes after the stretching procedures [27].

It was also witnessed that the acute outcomes produced by the FIFA 11+ on the four different groups of physical performance measures in the adolescent athletes engaged were alike to those found by the conventional football-related warm-up programme evaluated. Another important assumption of the study is that employment of the programme even at three days/week for four weeks could not produce any affirmative outcomes chronically on the performance measures examined [28].

Limitation(s)

The non homogeneity of the population as players in the study were from four different academies.

CONCLUSION(S)

There was no statistically significant difference observed between the experimental and control groups. Although, it was found that statistical significance was present when the within-group analysis was done for agility in FIFA 11+ and speed in a dynamic group. This suggested that the warm-up followed by the badminton players in the control group was equally effective in maintaining performance in comparison to FIFA 11+ and dynamic stretching.

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