

Effect of Circuit Training Program on Motor Fitness Components and Skill Abilities of Under - 19 Football Players

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Abstract: *The game of Football requires tremendous physical fitness played for 90 minutes, which involves basic movements such as kicking, running, jumping, rowing, dodging etc. This requires speed, strength, power, and agility wherein the brain improves coordination and concentration. Thus, promoting socialization, teamwork, and confidence building. Circuit training involves high - intensity aerobics, with the main aim of building muscle strength and endurance. It is an ideal form of exercise for footballers, as it combines resistance work with cardiovascular exercise for an all - round workout. Success in Football is dependent upon a variety of factors including the physical characteristics and physiological capacities of the players, their level of skill, their degree of motivation and tactics employed by them against the opposition. To determine the effect of circuit training on motor fitness components and skill ability of under - 19 football players. A pre - post design study involving 40 players who were randomly allocated to either experimental or control group. Pre and post assessments were done at the start and end of 8 weeks of circuit training or no program depending upon the allocated group. The experimental group showed significant improvement in all components of muscle strength, agility, power, speed, dribbling, juggling, and passing as compared to the control group at the end of 8 weeks of circuit training. Circuit training has shown to be effective in improving the motor fitness components and skill ability of under - 19 football players and can be incorporated in their training program.*

Keywords: Football, Circuit Training, Motor Fitness Components, Skill Abilities

1. Introduction

Globally, football is one of the most popular sports played and watched. It has been estimated by The Fédération Internationale de Football Association (FIFA) that 270 million football players are registered worldwide [1, 2]. Additionally, within India, it is the second most watched sport after cricket and has a well - designed league system constituting the Indian Super League, I - League, Second division leagues, and Youth leagues [3]. This increase in interest in the sport and opportunities to be engaged has also seen an increase in early preparation during the adolescent years for being able to be selected in the league system. Also, a worldwide trend for increased participation in organised sports by children and adolescents has been noted, although, there is evidence of lower physical fitness and increased prevalence of overweight in this population, giving rise to concern about the risk and severity of injury [4].

Football is a contact sport that requires physical aptitude and the ability to play at high levels of intensity [5], carrying a significant risk of injuries for all level players, regardless of age [6]. It has been found that musculoskeletal injuries are the most common injuries in youth sports [7], with an incidence of football - related injuries estimated to be 10–35 per 1, 000 playing hours in adult male players [8] and often higher in younger and less - skilled players [9]. Studies have found that injuries related to football have an association to both non - modifiable factors, such as sex and age, and modifiable factors, such as those that can be improved through training programs. Thus, it is imperative to research

into assessment and implementation of preventive soccer training routines [5, 10]

Currently, there exists preventative programs like FIFA 11+ program which has found to improve physical fitness components through resistance and neuromuscular exercise and prevent injuries among both sexes aged >13 year [11, 12]. Also, resistance training using High Intensity Circuit Training (HICT) has been considered beneficial in increasing the physical fitness components, including maintaining cardiopulmonary fitness [13]. The effect of circuit training has been explored in other sports and varied age groups [14, 15, 16, 17] and found to have promising results on domains of performance and other fitness components. These training programs focused individually on fitness components like muscle strength, speed, agility etc or skill ability depending upon the need of the sport. However, the demand on the players in football is multi - faceted and requires assessment as well as training aiming at various motor fitness components and skill abilities as a broader viewpoint. Our research is an attempt to bring to the fore a possible approach to the circuit training process of adolescent football players. Therefore, the purpose of our study is to determine the effect of circuit training program on motor fitness components and skill ability of under - 19 football players.

2. Review of Literature

1) Dr. Ramdas R. Jadhav (2022) Effect of circuit training programme on selected physical fitness variables among sports person [18]

The purpose of this study was to find out the effect of circuit training on selected physical fitness variables among sports persons. 40 male college sports persons ($n=40$) were randomly selected as a subject and their age ranged between 18 to 25 years. The selected subjects were randomly assigned into two equal groups such as circuit training group (CTG) and control group (CG) with twenty subjects each ($n=20$). The experimental (circuit training) group underwent their training for six weeks and a session on every day. Control group was not undergone any specific training apart from their regular activities. The data was collected before and after six weeks of training period. Independent t - test was applied for calculate the differences between both groups. The level of significance was set at 0.05 levels. It was concluded based on results that circuit training has significant effect on all selected physical fitness variables.

2) Dr. V. Vallimurugan, P. Sounderrajan, S. Senthil Kumaran (2022) Effects of circuit training on selected physical fitness variables among hockey players [19]

This study was designed to investigate the impact of circuit training on selected physical fitness variables among hockey players. Thirty men hockey players were randomly selected with age ranged from 21 to 25 years. They were divided into two equal groups. The group 1 is considered as experimental group (circuit training) and group 2 was considered as control group. Pre - test was conducted on Speed, Agility, and leg explosive power for both the groups and the readings were carefully recorded in their respective unit as pre - test score. After the pretest, the Experimental group was treated with specific circuit training, for a duration of 45 minutes, three days per week for a period of six weeks. The control group was not treated with any special training. After six weeks of Training post test was conducted and the readings were carefully recorded in their respective units as post test scores. The pre and post - test were taken for analysis. The collected data on physical fitness variables due to six Weeks circuit training was analysed by dependent 't' test with 0.05 level of confidence. From the results, it was found that there was a significant improvement on physical fitness variables among hockey players.

3) SüleymanViran, UmutCanli, Cem Kurt (2022) Relationship Between Soccer - Specific Skills and Skill - Related Fitness in Adolescent Soccer Players [20]

The purpose of this study was to examine the relationship between soccer - specific skills and skill - related fitness in adolescent football players. Thirty male soccer players (age: 15.86 ± 0.69 years; football experience 7.10 ± 1.70 Years) were recruited from a soccer team. Soccer players performed both soccer - specific skill tests and skill - related fitness tests. Soccer - specific skill tests included the Loughborough soccer passing test, Yeagley soccer test, Mor-Christian general soccer ability skill test, and the skill - related fitness tests consisted of the alternate - hand wall - toss Test, countermovement jump test, sport - specific core muscle

strength and stability plank test, pro - agility test, 20 - m Sprint test, and lower - quarter Y balance test. Pearson product - moment correlation analyses revealed a moderately positive correlation among the Mor-Christian general soccer ability skill test score (dribbling), pro - agility test score ($r = 0.44$, $p = 0.01$), and 20 - m sprint time ($r = 0.43$, $p = 0.01$). There were no correlations among other variables for both the soccer - specific skill tests and skill - related fitness tests. The authors concludes that dribbling drills in soccer should be supported by agility and sprint exercises to increase dribbling speed by Soccer trainers and soccer players.

4) J Hum Kinet (2021) The effects of a 6 - month high - or moderate - intensity total - body circuit training program on physical fitness in prepubertal soccer players [21]

The purpose of this study was to examine the effects of a 6 - month high - or moderate - intensity total - body circuit training (CT) program on physical fitness in prepubertal soccer players. Sixty - seven prepubertal boys with a mean age of 11.2 ± 0.7 years completed the study. Participants from a soccer academy were randomly assigned either to a high - intensity CT group (HCT, $n = 22$) or a moderate - intensity CT group (MCT, $n = 24$). A control group (CON, $n = 21$) comprised age - matched individuals who were not involved in any regular training regime. CT protocols were included in the experimental group's training sessions 3 times per week over 24 weeks as part of their usual weekly training regime. Physical fitness was evaluated by the Eurofit test which included the flamingo balance (FLB), plate tapping (PLT), sit - and - reach (SAR), standing broad jump (SBJ), handgrip (HG), sit - ups (SUP), bent arm hang (BAH), 10×5 m shuttle run (SHR), and the Physical Working Capacity test (PWC170). The two - way ANOVA indicated group \times time interaction effects for 5 components: the largest was for the SBJ (F_2 , $63 = 42.895$, $p < 0.001$, $\eta^2 = 0.577$), and the lowest for the SHR (F_2 , $63 = 5.006$, $p < 0.01$, $\eta^2 = 0.137$) indicating better improvements in the HCT compared to the MCT group. In conclusion, the intensity - controlled total - body CT protocol incorporated into a standard soccer training program is effective for enhancement in physical fitness performance in prepubertal soccer players.

5) Maninder Singh and Dr. Ashok Kumar Sharma (2020) Effect of circuit training on physical fitness variables of Kabaddi players [22]

The purpose of the present investigation was to determine the effects of circuit training on physical fitness variables of Kabaddi players. Sixty physically active male Kabaddi players ($n = 60$) were selected as subjects and their age group ranged between 18 and 25 years. The researcher gave the 8 weeks circuit training to the experimental group and assessed pre and post results from the same group. Both experimental groups underwent their respective experimental treatment for eight weeks, five days a week and one session on daily. Circuit training was comprised into ten stations. The collected data was analysed using t - test at 0.05 level of significance. The result of the study revealed that there were significant improvement in physical fitness level of Kabaddi players after eight weeks circuit training.

Objectives:

- 1) To assess the motor fitness components and skill abilities of under - 19 football players
- 2) To study the effect of circuit training program on motor fitness components and skill abilities of under - 19 football players

3. Methods

The sessions of this pre - post cross - sectional study were conducted at a sports ground and on a beach for few specific drills between July and September 2022. Ethics was considered within the Department of Physical Education, University of Mumbai, India. This study was conducted according to the Declaration of Helsinki. STROBE guidelines were used to report the findings. All patients were provided with all the information regarding the study and verbal informed consent was taken prior to the session.

Participants

The sample size included 40 football players under the age of 19 with a mean age of 16.5 years, recruited from the student population of Mumbai. The sample size was based on the availability of the number of consenting patients between the period of July and September 2022 through convenience sampling method. The sample included only boys, considering the teams from where the players were recruited were either university level or semi - professional level.

Inclusion criteria consisted of healthy individuals aged between 14 and 18 years. Participants were excluded if they reported an injury or severe muscle pain during the data collection sessions; history of any health - related disorder or infection or systemic disease in the last 6 months; failure to comply or follow with instructions during assessment sessions. Also, the participants were asked if they were on any medications for a known health diagnosis.

Procedure

AF informed the participants about the objectives of the research project, the days, the schedule, and the place where the sessions would take place. Data collection was carried out for 10 weeks. In the first week, assessments were conducted based on the list provided in Table 1. The participants were then allocated randomly into two groups – one experimental and other control group with 20 each. The experimental group received a customised designed training program which was delivered weekly for a duration of 8 weeks (5 days/ week). Whilst the control group was instructed to do the same warm up and continue with their usual daily routine.

Table 1: List of tests conducted as part of the pre and post training assessments. The details of each test have been provided in Appendix 1

Variables	Test	Unit
Motor fitness components		
Muscular Strength	Bent Knee Sit - Ups	Counts
Agility	Shuttle Run	Seconds
Explosive Power	Standing Broad Jump	Meters
Speed	50 Meters Dash	Seconds
Skill ability		
Dribbling	30 meters running test	Counts
Juggling	SAI football skill test	Seconds
Passing	McDonald Soccer skill test	Counts

Training program

The participants were engaged in general and specific warm up exercises prior to the circuit training program which was designed by the research team. The whole training session was conducted for 90 minutes and was delivered on alternate days for three days in a week, Monday, Wednesday and Friday. While sessions on Tuesday and Thursday included small - sided games (SSGs); with Saturday and Sunday as rest days. The details of the whole 8 week program has been provided in Table 2.

Warm up: Walking (2mins) Jogging (5 mins) Stretching exercises (15 mins)

Table 2: The Eight - weeks training program. Key – W – week; secs – seconds; mins – minutes

S. No.	Exercise (3 sets of each)	Duration (secs)					Station Exchange duration (secs)				
		W1	W2 & W3	W4 & W5	W6 & W7	W8	W1	W2 & W3	W4 & W5	W6 & W7	W8
1	On the spot high knee	15	30	45	45	15	15	30	30	30	15
2	Single - leg lateral broad	15	30	45	45	15	15	30	30	30	15
3	Skipping	15	30	45	45	15	15	30	30	30	15
4	Front hops	15	30	45	45	15	15	30	30	30	15
5	Squat jumps	15	30	45	45	15	15	30	30	30	15
6	Lateral jump over cones	15	30	45	45	15	15	30	30	30	15
7	Zigzag run	15	30	45	45	15	15	30	30	30	15
8	Step up	15	30	45	45	15	15	30	30	30	15
9	Passing the ball 10m	15	30	45	45	15	15	30	30	30	15
10	Dribbling cone 10m	15	30	45	45	15	15	30	30	30	15
Recovery Time after 1 set (mins)		1	1	1	1	1					
1 set time duration (mins)		6	11	13	13	6					
Small - sided games (SSGs) (mins)		15	15	15	15	15					
Cool down (mins)		10	10	10	10	10					
Total Session (mins)		75	80	85	85	75					

Statistical Analysis

The paired samples t - test was used to verify whether the pre and post training scores of the participants were

significantly different. The level of significance chosen to study the significance of the difference between means obtained by using mean difference method and analysis of

variance was set at a 0.05% level of confidence, which is considered adequate for the purpose of the study. Statistical analyses were performed using GraphPad version 9.0 (Dotmatics, 2021).

4. Results

The sample size included 40 football players under the age of 19 with a mean age of 16.5 years, recruited from the student population of Mumbai. The age of all the participants ranged between 14 and 18 years. The subjects were randomly allocated into two groups.

Table 3: Comparison of pre - assessment versus post - assessment of motor fitness components and skill ability within the experimental group (n = 20)

		Mean ± SD	SEM	P value	Significance
Muscle Strength	Pre	30.20 ± 2.71	0.61	0.001	Highly significant
	Post	45.40 ± 4.96	1.11		
Agility	Pre	5.85 ± 0.81	0.18	0.0001	Highly significant
	Post	9.25 ± 0.72	0.16		
Power	Pre	7.25 ± 0.97	0.22	0.0007	Not significant
	Post	9.80 ± 0.41	0.09		
Speed	Pre	8.88 ± 0.74	0.16	0.001	Highly significant
	Post	7.85 ± 0.53	0.11		
Dribbling	Pre	6.02 ± 0.42	0.09	0.0001	Highly significant
	Post	5.56 ± 0.39	0.08		
Juggling	Pre	13.90 ± 4.60	1.03	0.0001	Highly significant
	Post	19.45 ± 4.93	1.10		
Passing	Pre	21.10 ± 2.94	0.66	0.0001	Highly significant
	Post	25.35 ± 3.30	0.74		

Table 4: Comparison of pre - assessment versus post - assessment of motor fitness components and skill ability within the control group (n = 20)

		Mean ± SD	SEM	P value	Significance
Muscle Strength	Pre	29.70 ± 2.20	0.49	0.1189	Not significant
	Post	30.50 ± 3.15	1.71		
Agility	Pre	6 ± 0.97	0.22	0.0047	Significant
	Post	6.35 ± 0.93	0.21		
Power	Pre	7.15 ± 0.81	0.18	0.7157	Not significant
	Post	7.20 ± 0.89	0.20		
Speed	Pre	8.36 ± 0.62	0.14	0.0012	Highly significant
	Post	8.24 ± 0.60	0.13		
Dribbling	Pre	6.03 ± 0.41	0.09	0.0152	Significant
	Post	5.98 ± 0.43	0.09		
Juggling	Pre	13.25 ± 3.93	0.88	0.0880	Not significant
	Post	13.65 ± 3.67	0.82		
Passing	Pre	21.50 ± 2.74	0.61	0.0057	Highly significant
	Post	22.15 ± 2.78	0.62		

Table 5: Comparison of post - assessment versus post - assessment of motor fitness components and skill ability between the experimental and control groups

	Group	Post Mean ± SD	P value	Significance
Muscle Strength	Experimental	45.40 ± 4.96	0.001	Highly significant
	Control	30.50 ± 3.15		
Agility	Experimental	9.25 ± 0.72	0.0001	Highly significant
	Control	6.35 ± 0.93		
Power	Experimental	9.80 ± 0.41	0.0001	Highly significant
	Control	7.20 ± 0.89		
Speed	Experimental	7.85 ± 0.53	0.2427	Not Significant
	Control	8.24 ± 0.60		
Dribbling	Experimental	5.56 ± 0.39	0.0023	Highly significant
	Control	5.98 ± 0.43		

Juggling	Experimental	19.45 ± 4.93	0.0011	Highly significant
	Control	13.65 ± 3.67		
Passing	Experimental	25.35 ± 3.30	0.0020	Highly significant
	Control	22.15 ± 2.78		

5. Discussion

This study examined the effect of circuit training on motor fitness components and skill abilities of under - 19 football players. The main finding was that the overall mean scores for all the components of motor fitness and skill abilities were found to increase for the experimental group who received the circuit training.

To achieve fitness and performance goals for a competition, different training game formats as well as high - intensity training are taken into consideration by coaches and physical trainers to better design and prepare training protocols [23]. Various integrated training methods like small - sided games (SSGs), circuit training, mini goal games, match simulation, compound training have been studied. This research aimed at exploring the effect of a circuit training which had a component of SSGs intertwined in the weekly schedule.

The key findings of the study include that the experimental group showed an improvement on all motor fitness components like muscle strength, agility, explosive power and speed. This can be attributed to the training effects seen within the model of appropriate periodization which involves transferring a variety of performance variables (strength, speed - strength, strength endurance) to their highest rate of development with the aim of peaking at a precise time and avoiding stagnation, injury, or overtraining [24, 25]. It has been recommended that these objectives can be accomplished through taking into consideration the variables like training methods, contents, frequency, volume, and intensity in consecutive phases during different periods of the season with training program scheduled for between 2–10 weeks [24, 26]. This was achieved in the current study with a training program which was conducted for a period 8 weeks. Additionally, changes in the muscle morphology have been documented in a study done by Souza et al. [27] which found statistically significant gains in the muscle Cross - section Area (CSA) of the quadriceps after three training protocols of periodization over 6 weeks. Thus, highlighting the potential reason for the increase in post assessment scores of muscle strength, power, and speed of the football players after 8 week of circuit training which was designed on the concept of periodization.

Another aspect of the circuit training designed by the research team included Small - sided games (SSGs) embedded for 2 days within the five - day training week. There is evidence that SSGs involve intensity which were found to be harder than during actual matches and other game play, which could be related to greater neuromuscular fatigue and increased metabolic cost during matches [28]. This has been explained through the physiological changes which occur through SSGs which increase player’s intermittent efforts and in turn produce higher lactate concentrations [29], improving anaerobic performance. Thus, addition of this integrated approach must have caused further boost to the physiological processes producing the

results of overall improved performance. This is in line with the findings of other studies which found that only circuit training that aimed at improving physical fitness did not bring about changes in sport - specific skills as it did not simulate real competitive conditions [23].

An alternate explanation to the significant improvements across all the domains of motor fitness components and skill abilities in those who received circuit training (SSGs inclusive) would be that SSGs offer additional advantages, improving essential neuro - muscular and cognitive skills such as reaction time, decision - making, and change - of - direction speed [30]. Furthermore the participants must have also experienced greater motivation [31] and enjoyment [32] when performing their training as they are more sport - specific. This integrated circuit training also provided the research team flexibility to take sessions across pitch, sports ground as well as beach which would have further provided varied intensity of training.

Lastly, there exists substantial evidence which have studied about the effects of interval training and circuit training on $\dot{V}O_2$ max improvement [33, 34] and on lung function resulting in increased respiratory muscle, increased lung compliance, and reduced airway resistance, further enhancing the muscle mass [35]. Although, measurement of $\dot{V}O_2$ max was not conducted in this study but we can potentially assume that an improvement in cardio - pulmonary endurance must have further contributed to the findings of this study as many of the assessments were time based targeting the endurance component of the fitness.

6. Conclusion

In this study, it was found that circuit training which had an integrated small - sided games (SSGs) showed better improvement on motor fitness components and skill abilities compared to only conventional physiotherapy.

7. Future Implications

Training protocols involving circuits for football players under the age of 19 could consider involving different training methods like integration of small - sided games (SSGs). In addition multiple training methods could be compared and examined for their efficacy in players with different demographic and level of play.

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Appendix:

Assessment Procedure

1) Muscular strength - Sit up

Aim: To measure abdominal muscular strength

Equipment: Mats, stopwatch

Procedure: The players had to lie flat on their back with knees bent and have their foot on the floor with both heels no more than one foot from the buttocks, with knees angle no less than 90 degrees. The fingers were interlocked and placed behind their neck with elbows touching the floor. The feet were securely held by a partner.

The subjects have curled up to a sitting position and touch the chest to the knees.

Scoring: The score is the maximum number of sit - ups completed in 60 seconds.

2) Agility – Shuttle Run 4×10 meter

Aim: To examine speed, build strength and endurance

Equipment: An area on the track or on the football ground with 10 - meter distance. Stopwatches required for this test.

Procedure: Footballs were placed in a straight line, 10 meters apart, with the first ball 10 meters from the starting line.

On the signal “GO”, players were asked to do sprints to the first ball and dribble it back to the start, then turn and collect back the second ball, and so on. It is calculated based upon number of balls they were able to bring behind the line.

Scoring: Shuttle Run test with football in a 4 x 10 - meter area was taken and total time in seconds was noted.

3) Explosive power - - Standing Broad Jump

Aim: To assess the explosive strength

Equipment: Floor with take - off mark and tape to measure.

Procedure: The players were asked to stand with their feet several inches apart and with their toes just behind the take - off mark. They had to swing their arms and bend their knees in making the jump forward. Both feet had to leave the floor at the same time. The start of the jump had to be made from a static position.

Scoring: The distance between the takeoff line to the nearest point of landing was noted. Three trials are allowed and the best one is taken.

4) Speed and acceleration - - 50 METER DASH

Aim: To measure speed

Equipment: An area on the track or on the football ground with 50 - meter distance. Stopwatch was required for this test.

Procedure: After slight warm up, the players were asked to start the run from behind the starting line but only after the command 'go'. They were given them enough time to practice and only one trial was given for the final test.

The subject could take any position from behind the starting line i. e., the standing start or the sitting start. On the order 'go' the subject had to run at their best and would not stop or slow down before the finish line.

Scoring: The time taken by the subject to reach the finishing line and the time recorded with the stopwatch was the score of the subject. Time taken was recorded in seconds.

5) Dribbling - - 30 - meter run with the ball

Aim: To assess the speed and control of U 19 football players while running.

Equipment: A stopwatch, footballs, cones, marking powder and measuring tape.

Procedure: Two straight lines, 30 meters apart, were marked. The player was instructed to stand behind the marked line without touching the line with the football placed on the line. On the signal Go, the stopwatch was started and the subject was instructed to start running with the ball as fast as possible to reach the 30 - meter finish line, by pushing the ball as fast as possible to reach the 30 - meter finish line. By pushing the ball with the leg control and by making minimum of 4 inches with the ball with each touch including the first touch

Scoring: Time was measured from the interval of starting "Go" until the ball and the subject reached the finish line. Each subject was given two attempts at intervals of 30 seconds and the best performance timing was recorded.

6) Juggling - - SAI football skill test

Aim: To assess balance, agility, reaction ability and sense of touch of the ball

Equipment: Football and Whistle.

Procedure: The player was instructed to keep the ball in the air by juggling continuously and was told that he may use any part of the body except hand while juggling. The subject was allowed to throw the ball in the air or to bounce the ball on the floor and start juggling till the subject was able to juggle the ball without dropping it on the ground.

Scoring: The number of touches made by the subject continuously. The better performance out of two attempts was converted into points.

7) Passing - - McDonald Soccer Skill Test

Aim: To measure general soccer ability, though mainly trapping and passing.

Equipment: wall, 30 feet wide and 11.5 feet high, 3 soccer balls and stopwatch.

Procedure: A soccer ball is placed on a line, marked 9 feet (2.743 meters) from the wall. Another two soccer balls are left 9 feet behind the line in the center of the test area. On the signal, "Go, " the player had to kick the ball against the wall as many times as possible for 30 seconds. In the event of a wild kick, the player may either retrieve the original ball or use one of the two spare balls. (it is OK to use the hands

to retrieve a ball). All kicks had to be performed from the ground behind the restraining line. The test was repeated four times.

Scoring: The number of kicks in each 30 second period was recorded, with the highest total being the score.