

# The effect of short period high-intensity circuit training-modified FIFA 11+ program on physical fitness among young football players

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**Submission date:** 14-Mar-2020 04:13PM (UTC+0700)

**Submission ID:** 1275446476

**File name:** 11\_program\_on\_physical\_fitness\_among\_young\_football\_players.pdf (505.75K)

**Word count:** 2800

**Character count:** 25719

ORIGINAL ARTICLE  
 SECTION

8  
**The effect of high-intensity circuit training-modified FIFA 11+ program on physical fitness among young football players**

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ABSTRACT

**BACKGROUND:** Studies showed that FIFA 11+, the football injury prevention program, can improve physical fitness components through resistance and neuromuscular exercise. Currently, resistance training using High Intensity Circuit Training (HICT) is considered beneficial in increasing physical fitness component, including maintaining cardiopulmonary fitness. The purpose of this study was to evaluate the effect of HICT modified- FIFA 11+ training on the physical fitness components and cardiovascular (CV) training intensity of young football players.

**METHODS:** Thirty-nine football players were recruited by purposive random sampling to the football academies in Yogyakarta, Indonesia. The players were randomized into two groups; 20 players were in the experiment (EXP) group and 19 players were in the control (CON) group. The EXP group performed HICT-modified FIFA 11+ exercise and the CON group performed standard FIFA 11+. HICT modification was performed in the EXP group only in part 2 of FIFA 11+ (strength, power, and balance training) while the other parts were regular. Both groups performed the intervention 3 times per week for 4 weeks. All players completed a pre- and post-intervention physical fitness tests comprising the core strength (plank test), leg strength (leg dynamometer) and agility (Illinois test). Heart rate (HR) was monitored in both groups while exercise was being implemented to measure the CV training intensity. Changes in performance (pre- versus post-intervention) of each group were analyzed using paired t-test and Wilcoxon test. Statistical significance was set to  $P < 0.05$ . Twelve players dropped out in this research.

**RESULTS:** This study showed that core strength increased significantly in both groups ( $P = 0.00$ ). The EXP group had higher CV training intensity (HR max 91%; mean HR 74%) than the CON group (HR max 90%; mean HR 66%).

**CONCLUSIONS:** Results suggest that HICT modified FIFA 11+ can be implemented as an alternative program to increase the physical fitness components and also CV training intensity among young football players.

(Cite this article as: Zein MI, Saryono S, Laily I, Garcia-Jimenez JV. The effect of high-intensity circuit training-modified FIFA 11+ program on physical fitness among young football players. J Sports Med Phys Fitness 2020;60:000-000. DOI: 10.23736/S0022-4707.19.09813-X)

**KEY WORDS:** Soccer; Circuit-based exercise; Athletes; Athletic injuries; Accident prevention.

Football is classified as a high-risk sport especially among young players.<sup>1-3</sup> It has become a concern since football is also a popular sport that is beneficial for health. International Football Federation (FIFA) through their research department FIFA-Medical Assessment and Research Center (F-MARC) has introduced a football injury prevention program called FIFA 11+ and has disseminated worldwide.<sup>4, 5</sup> The program consists of three parts which combine the warm-up and stretching exercises with several neuromuscular training. The first and third parts focus on running exercise, dynamic stretching and direction

changes. The second part focus on neuromuscular training such as strengthening, balance, plyometric and agility.<sup>6</sup> FIFA 11+ is a very practical exercise which does not involve any additional training equipment excepts ball and cones. It can be applied as a 20-minutes warm-up in every training session. Studies showed that routine exercise of FIFA 11+ can reduce the incidence of injury in young, amateur, male and female football players.<sup>7-9</sup>

The potential mechanism of injury reduction of FIFA 11+ is the training effect, especially in the part 2 exercise. Increasing neuromuscular fitness components can correct

muscle imbalance, posture and improve body control, thus reduce the risk of injury.<sup>10-12</sup> Herman et al showed that exercise program which includes strengthening, balance and agility exercise could prevent injury effectively.<sup>13</sup>

In conjunction, high-intensity circuit training (HICT) lately has gain popularity in training method. This method is performed by repetitive weight exercise in a continuous fashion, moving from one station to another with a minimal rest interval between stations. It usually applied in a short duration (7 to 10 minutes) of calisthenics (rhythmic bodily exercises performed without weight equipment) exercise.<sup>14, 15</sup> Despite HICT is classified as a weight training exercise, nonetheless, it is deemed to be able to train cardiovascular as well as muscle strength.<sup>16-18</sup> Cardiovascular capacity is an important fitness component in football games.

Short rest intervals and adequate training stimulus in HICT are the keys to improve cardiovascular capacity. A study from Gonzales showed that circuit training with 15 seconds rest interval has given a significant improvement of cardiovascular capacity, and it appears to be multi-benefit mode exercise with minimal risk.<sup>19</sup>

FIFA 11+ training program has proven to be able to improve physical fitness components. It can be maximized by implementing HICT method to improve both cardiovascular and musculoskeletal fitness. Optimum physical fitness is expected to enhance player's performance and reduce the risk of injuries.

The objective of this study was to determine the effect of a short period of higher training intensity of the standard FIFA 11+, which is applied as the HICT modified FIFA 11+ program in improving physical fitness components that can affect in injury prevention *i.e.* core strength, leg strength and agility risks, and its effect to cardiovascular capacity among young football player compared to the standard FIFA 11+. We hypothesize that the HICT modified FIFA 11+ may improve core strength, leg strength and agility with higher cardiovascular training intensity compared to the current standard FIFA 11+.

## Materials and methods

### Participants

This experimental study recruited young male football players from football academies in Yogyakarta, Indonesia to take part in a 4-week intervention. The football academies were chosen by a purposive sampling. Two football academies that met the selection criteria were participated in this research. Selection criteria included: 1) having permanent and adequate football training facilities; 2) having a regular

football training schedule at least 3 times a week. Randomization was performed to determine which school was selected as the experiment (EXP) and control (CON) groups.

All subjects from both groups were members of the football team. Total 39 football players who met the criteria were included in this research. Inclusion criteria were: 1) male footballers aged 15 to 19 years; 2) members of the selected football academies; 3) only performing routine exercise according to the football academies; 4) passing medical check-up; 5) obtaining the consent of parents/guardians (by signing an informed consent research sheet); 6) being committed to attend the complete series of the study. This study was approved and accepted for research ethic clearance from the Faculty of Sports Science of Yogyakarta State University, in Yogyakarta, Indonesia.

### Intervention

The EXP group underwent the HICT modified FIFA 11+ program while the CON group underwent standard FIFA 11+ program. Both groups performed the intervention three times per week within four weeks as a warm-up program. Therefore, the players do not need to warm up before performing the intervention.

The CON group performed the standard FIFA 11+ as mentioned in the manual guideline from FMARC.<sup>20</sup> The HICT modification in the EXP group only implemented in part 2 of FIFA 11+ (strength, power, and balance training) while the other parts were performed regularly. Six exercises in part 2 of FIFA 11+ — namely plank, side-plank, Nordic hamstring, single-leg stance, squat, and vertical jump — were converted into high-intensity movements. Nordic hamstring training was replaced by bridge hamstring while single leg stance was replaced by deadlift. The exercises in this part were conducted for 30-40 seconds with 10 seconds of resting time. Once a single exercise was completed, subjects must move to the next exercise until they have finished all exercises and then repeated for another cycle (two sets of circuit training).

The coach of EXP and CON group were trained for the HICT modified FIFA 11+ and standard FIFA 11+ in two sessions with a duration of approximately 60-90 minutes as a preparation for the research intervention to be properly conducted.

### Heart rate monitoring

Heart rate (HR) monitoring was done in both groups to measure the maximal HR, mean HR and intensity while exercise was being implemented. Three heart rate monitors (Polar™, software Polar Team™) was attached to

subject's chest in both groups during the intervention and the heart rate was recorded in real time using iPad mini™.

#### Data collection

Baseline data (e.g. name, birthdate, address, age, height, weight) was collected in both groups. The subjects then performed physical fitness tests twice, before and after the 4 weeks of intervention. The tests were conducted at the same time (16:00 local time  $\pm$ 1 hour), in the same football field and condition with the same trained staff. The measurement of physical fitness conducted in this study are: 1) the plank test to measure the core muscle strength; 2) the leg dynamometer test to measure the leg muscle strength; 3) the Illinois Agility Test to measure the agility. Each test was performed twice per session and the best test result was taken for data analysis. Subjects were allowed to do a trial on each type of test.

#### Statistical analysis

Statistical analyses were conducted using SPSS v. 25.0 (SPSS Inc., Chicago, IL, USA). Normality test was performed using Shapiro Wilk test because there were less than 50 subjects. Descriptive statistics were used to calculate the mean and standard deviation. The independent *t*-test was used to compare subjects' characteristics between groups at the baseline and Mann Whitney as an alternative test if the data were not normally distributed. The paired *t*-test was used to compare the differences between pre and post intervention result in the EXP and CON groups and Wilcoxon as an alternative test if the data were not normally distributed. Analysis of covariates (ANCOVA) test was performed to compare the post-test results between groups by considering the pre-test data as covariates. A score of  $P < 0.05$  was considered as statistically significant.

## Result

#### Participants

A total of 39 subjects (20 subjects in the EXP group and 19 in CON group) participated in this research. From the total, 12 subjects dropped out, leaving 14 subjects in the EXP group and 13 in the CON group for the final analysis. The flowchart diagram is displayed in Figure 1.

There were no significant differences for baseline characteristics between subjects except in age component. The EXP group presented a slightly older age ( $15.71 \pm 0.72$  years old) compared to the CON group ( $14.92 \pm 0.76$  years old;  $P = 0.06$ ). Characteristics of subjects in each group are shown in Table I.

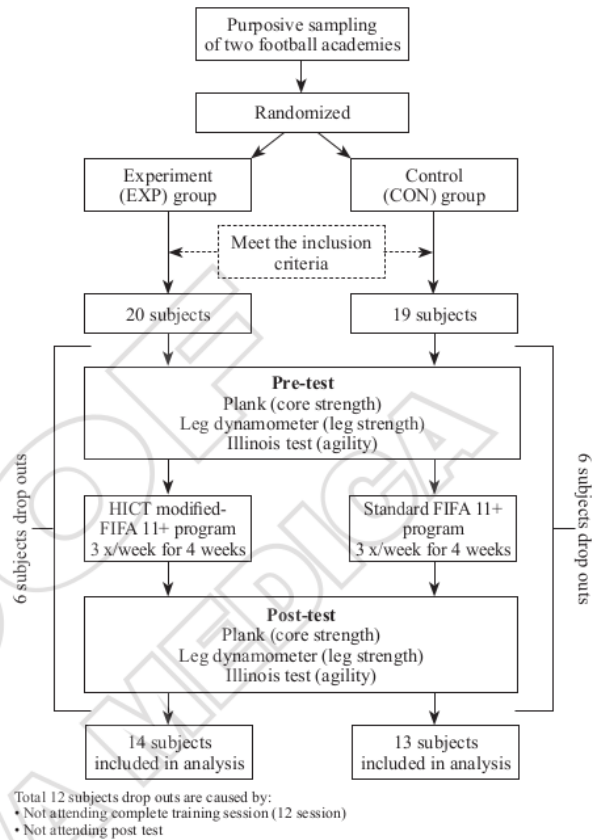


Figure 1.—Flow chart of the intervention.

TABLE I.—Baseline characteristics of the subjects.

Characteristics	EXP group (N.=14)	CON group (N.=13)	P values
Age, years	15.71 $\pm$ 0.72	14.92 $\pm$ 0.76	0.006 #
Weight, kg	55.93 $\pm$ 9.44	55.23 $\pm$ 9.62	0.94 #
Height, m	1.65 $\pm$ 8.03	1.64 $\pm$ 0.06	0.25
Body Mass Index, kg/m <sup>2</sup>	20.36 $\pm$ 2.21	20.42 $\pm$ 2.72	0.95
Core strength, s	141.50 $\pm$ 61.09	107.69 $\pm$ 34.44	0.89 #
Leg strength, kg	108.64 $\pm$ 20.54	98.62 $\pm$ 23.22	0.65
Agility, s	16.48 $\pm$ 0.46	16.32 $\pm$ 0.44	0.32 #

# Analysis was performed by Mann-Whitney.

#### Effects of intervention HICT Modified FIFA 11+ and Standard FIFA 11+

The measurement of physical fitness consisted of core strength, leg strength, and agility using paired *t*-test, was carried out pre- and post- implementation of the interven-



tion in the EXP and CON groups. The test result showed a significant increase in the core strength component in both group ( $P=0.00$ ). The leg strength component also improved in both of EXP and CON group but statistically insignificant ( $P=0.72$  and  $P=0.45$ , respectively). The agility component was significant decline in EXP group ( $P=0.00$ ) and statistically insignificant in CON group ( $P=0.18$ ). Result are presented in Table II.

#### Analysis of covariate (ANCOVA) test

The baseline fitness components (pretest) were covariates which were looked into account in affecting the improvement of post test results. The ANCOVA analysis demonstrates that the core strength and leg strength components ( $P=0.000$  and  $P=0.029$ , respectively) were the variables which influenced the training results. The different types of intervention (HICT modified FIFA 11+ and standard FIFA 11+) showed statistically insignificant post-test result in core and leg strength ( $P=0.972$  and  $P=0.696$ ).

Meanwhile, the pre-test did not affect the post-test result ( $P=0.109$ ) of agility component. However, it was influenced by the type of intervention ( $P=0.000$ ). The results of the ANCOVA analysis are shown in Table III.

#### Monitoring heart rate during intervention into two groups

Heart rate monitor (Polar™) using the Polar Team™ software application was applied to monitor the maximum HR and mean HR during warm-up sessions between the two groups. The results of this monitoring are presented in Table IV.

The result showed that the HICT modified FIFA 11+ could give a higher cardiovascular training intensity compared to the standard FIFA 11+ program.

### Discussion

To the best of the authors' knowledge, this is the first study investigating the high-intensity circuit training modification effect of the FIFA 11+ warm-up program. Our main finding was HICT modified FIFA 11+ and standard FIFA 11+ could improve physical fitness components.

TABLE III.—Analysis of covariates (ANCOVA) test.

Components	P value		
	Intervention model	Pre-test baseline data	Corrected model
Core strength	0.972	0.000	0.001
Leg strength	0.696	0.029	0.061
Agility	0.008	0.109	0.000

TABLE IV.—Result of heart rate monitor in two groups during intervention.

Group	Maximal heart rate	Mean heart rate
EXP (N.=3)	91% HR <sub>max</sub>	74% HR <sub>max</sub>
CON (N.=3)	90% HR <sub>max</sub>	66% HR <sub>max</sub>

This study measures three physical fitness components that were considered to affect the decrease in injuries incidences, including the leg muscle strength, core strength, and agility. In a comparison of the three components, core strength showed a significant increase in both groups ( $P=0.00$ ).

“Core” consists of trunk muscles (abdominals, back), pelvic and hip region. These structures have an important role in neuromuscular control and stability of the body. Core functions as a pivot when the body movement changes its central gravity.<sup>21</sup> A study showed that core weakness is associated with injury, and core strengthening program could reduce the risk of injury.<sup>22</sup>

In our study, there was an increase in core muscle in both groups. The increased occurs because both groups trained the plank and the side plank. Researchers showed that plank and side plank are effective exercises to strengthen the core muscle, and they tend to positively effective in reducing injury rates.<sup>23, 24</sup>

The improvement of leg strength also occurred in both groups even though it was not statistically significant. Nevertheless, an increase in leg strength of an average of 3-5 kg in both groups could provide a good implication for performance and injury prevention. This increase occurs because the muscle strength and plyometric exercises in FIFA 11+ focus on the lower extremity which were the dominant region used in soccer sports. Although the EXP

TABLE II.—Changes of physical fitness components, pre-post intervention in EXP and CON group.

Components	EXP group (N.=14)			CON group (N.=13)		
	Pre-test	Post-test	P value	Pre-test	Post-test	P value
Core strength, s	141.5±61.09	162.71±81.03	0.00	107.69±34.44	134.38±34.29	0.00
Leg strength, kg	108.64±20.53	111.29±24.83	0.72	98.62±23.22	103.23±22.21	0.45
Agility, s	16.48±0.46	16.98±0.54	0.00	16.32±0.44	16.12±0.35	0.18

group strength training have been modified to be more dynamic with a higher intensity, the study showed that it still provides an improvement on the leg strength. Studies have shown that muscle strengthening exercises could reduce the incidence of lower extremity injuries such as hamstring strain or knee injury.<sup>25, 26</sup>

There is a change in the agility results in both groups. The EXP group experienced a statistically significant time deceleration ( $P=0.00$ ,  $\pm 0.5$  seconds) while the CON group showed an acceleration of  $\pm 0.2$  seconds which were not statistically significant. Nonetheless, changes in both groups did not have significant implications in players' performance during the games. Football is a sport with a wide area of play. Therefore, a change of agility of less than 1 second is considered as a non-significant effect on the game. Such changes may have positive implications for sports which use aspects of speed in the main assessment component, such as track and field (sprint, middle distance running).

Analysis of covariates (ANCOVA) test showed that baseline of physical fitness components (core strength and leg strength) affected the result of the post-test. This result were in line with Kraemer and Ratamess that initial physical fitness and training status plays an important role of progression during strength training.<sup>27</sup> In this research, we have tried to design two comparable groups by meeting the inclusion criteria and analyze using independent t-test to confirm that no significant difference of baseline physical fitness between group. However, ANCOVA analysis still showed that the initial physical fitness characteristics affected the post test results.

The significance magnitude of changes in the physical fitness components were influenced by the duration of intervention time. FMARC recommends that the FIFA 11+ is routinely performed 2-3 times per week for 10-12 weeks for a maximum effect.<sup>20</sup> The 4-weeks intervention in this study is considered as not enough to have an optimum physical fitness improvement. Nevertheless, the results of this study have shown a positive effect on the given intervention program and could serve as a basis for further research.

The installation of Polar<sup>TM</sup> heart rate is to observe the intensity of warming up in both groups. HR monitor showed that the EXP group had a higher cardiovascular training intensity than the CON group (EXP HR<sub>max</sub> 91%; mean HR 74% vs. CON HR<sub>max</sub> 90%; mean HR 66%). Consequently, this showed that the modification of part 2 of FIFA 11+ using the HICT method could increase the intensity of the exercise, which were useful in training cardiovascular ca-

capacity. Research showed that higher intensity of exercise elicits higher improvement of VO<sub>2max</sub>.<sup>28</sup> The mean HR in the EXP group (74% HR<sub>max</sub>) demonstrates that the intervention is categorized as vigorous exercise, which is a cardiovascular training zone.<sup>29</sup> Solanki et al documented that a 9-minute HICT exercise program for 6 weeks was able to build up cardiovascular capacity.<sup>30</sup> Correspondingly, a similar result was also shown by Vrachimis *et al.*<sup>30</sup> Moreover, other than the increased cardiovascular capacity, short interval resting of circuit training in the EXP group might promote adaptations and facilitates the ability to sustain high-intensity performance.<sup>31</sup>

In the EXP group, we also replaced some exercise from the standard version to provide an adequate training stimulus by increasing the volume of training (speed and repetition). Although they were replaced, the objectives of the exercise did not change, *i.e.* Nordic hamstring was replaced by hamstring bridge, which both of them are hamstring strength training. The single leg stance was replaced by a deadlift, which is also a balance training.

This study demonstrated that the implementation of modification of the FIFA 11+ program with the HICT method is feasible because of the similarities in training characteristic such as: 1) part 2 of the FIFA 11+ is a resistance calisthenics training; 2) the short time of circuit weight training (approximately 10 minutes each session).

#### Limitations of the study

In this study, we only used three pieces of HR monitors for each group due to equipment limitation. Monitoring was performed on the subjects who were selected randomly at the beginning of the study. The recorded data then represents the average of exercise intensity in each team.

#### Conclusions

This study demonstrated that the HICT modified FIFA 11+ and the standard FIFA 11+ could improve physical fitness components in reducing injury risk effect. The HICT modified FIFA 11+ was able to increase cardiovascular training intensity compared to the standard FIFA 11+. Although no VO<sub>2</sub> max measurements were taken in both groups, HICT modified FIFA 11+ is considered to be beneficial in improving cardiovascular capacity aspect in football players.

This research concludes that HICT modified FIFA 11+ can be a promising warm-up alternative in football training. Further research is needed to look at the effect of the implementation of HICT modified FIFA 11+ in increasing VO<sub>2</sub>Max and reducing the incidence of injury.



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**Conflicts of interest.**—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

**Funding.**—This research receives a grant from the Faculty of Sports Science of Yogyakarta State University (Decree of the Dean: 180-2016; Letter of Agreement No.: 599/UN34.16/PL/2016).

**Authors' contributions.**—Muhammad I. Zein: research leader, built the design of the research, performed data analysis and interpretation. Saryono: data collection, analysis, and interpretation, drafted the article. Inarota Laily: drafted the article, revised the intellectual content, gave final approval for publishing. José V. Garcia-Jimenez: revised the intellectual content, gave final approval for publishing.

Article first published online: September 23, 2019. - Manuscript accepted: September 12, 2019. - Manuscript revised: July 15, 2019. - Manuscript received: March 4, 2019.

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GRADEMARK REPORT

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FINAL GRADE

**/100**

GENERAL COMMENTS

**Instructor**

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