



High Intensity Continuous Running Training's Effects on Cardiorespiratory Fitness of University Football Players

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ABSTRACT

Cardiorespiratory fitness is essential for football performance, influencing aerobic capacity, recovery, and respiratory efficiency during prolonged, intermittent high-intensity match play.

Aims of the Study: This study examined the effects of an 8-week HICRT program on Maximum Oxygen Uptake (VO₂max), Heart Rate Recovery (HRR), Forced Vital Capacity (FVC), and Forced Expiratory Volume in one second (FEV₁) among university football players.

Methodology: Forty healthy male players from The University of Kamalia, District Toba Tek Singh, were randomly assigned to a Control Group (n=20) and an Experimental Group (n=20). Pre- and post-test measurements were recorded for both groups under standardized conditions. The Experimental Group completed a supervised 8-week HICRT program comprising three sessions per week at 75-90% of maximal heart rate with progressive intensity, while the Control Group maintained regular training and daily activities.

Results: Significant improvements were observed in the Experimental Group for VO₂max (40.05±1.66 to 46.65±2.36 ml/kg/min, p<.001), HRR (25.75±1.25 to 19.25±1.44 beats/min, p<.01), FVC (3.81±0.12 to 4.41±0.14 L, p<.01), and FEV₁ (3.12±0.15 to 3.79±0.15 L, p<.01), whereas the Control Group showed no significant changes. Post-test comparisons also significantly favored the Experimental Group across all variables (p<.05).

Conclusion: The findings indicate that HICRT is an effective, time-efficient strategy to enhance cardiorespiratory fitness, aerobic power, and pulmonary function in university football players, providing valuable implications for coaches and conditioning specialists.

1. Introduction

Cardiorespiratory fitness plays a vital role in sports performance, particularly in game like Football, where, strength, agility, sustained physical efforts and endurance are needed. It gives consideration to the ability of the respiratory and cardiovascular systems to supply oxygen to the muscles during continue physical workouts. For university players, enhancing cardiorespiratory fitness is not only vital for optimizing performance on the ground but also for promoting recovery and reducing fatigue. Among

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the several training approaches used to develop this fitness, High Intensity Continuous Training (HICT) is prominent as a practical and regenerative method.

HICT involves balance aerobic workout performed at a moderate intensity, normally ranging from 70% - 85% of a participant's Maximum Heart Rate (MHR) (Mandsager et al., 2018). It is based on sustained workout lasting anywhere from 20 to 50 minutes or extended. The basic objective of HICT is to enhance aerobic capacity by improving the capability of the respiratory and cardiovascular system. The activities such as, swimming, cycling, and jogging at a steady rate are the instances of moderate intensity continuous training. The researches have proved that HICT enhances the VO₂max, fat metabolism, and overall cardiovascular health (Carvalho et al., 2018). The Footballers can benefit from adding HICT to their training regime as a good base for cardiorespiratory endurance.

HICT can be said to be focusing on the aerobic energy system, creating stability in endurance, enabling recovery and adaptation by reducing total training fatigue (Qi et al., 2026). Football players, who have to possess the capacity for fast recovery and continue doing so, can benefit greatly from HICT. They experience low possibilities of getting injured or overtrained, yet manage to enhance performance through outstanding cardiorespiratory fitness. HICT cycles should be carried out at least 4 to 5 days per week, and each cycle was take 20 to 50 minutes. These exercises perfectly fit the schedule of university Football players, who need to combine studies and practice (Hostrup & Bangsbo, 2023).

As far as football is concerned, athletes should do high-intensity actions like sprinting, tackling, and turning directions for the whole time of the game. Such requirements put the constant load on the heart, lungs, and muscles, which makes cardiorespiratory fitness an important performance determinant. For that reason, its development becomes an obligatory part of athletes' training (Franklin et al., 2022).

However, most university students do not undergo proper physical training due to various factors such as academic pressure and the unavailability of professional training facilities (Thomas et al., 2024). Through such continuous overload, the body's cardio-respiratory system adjusts itself much faster, which results in better oxygen delivery and utilization. For footballers, this approach is especially appropriate as it imitates the physiological stress of playing (Thomas et al., 2024). High-intensity cardiovascular exercises performed by training programs over time lead to physiological responses including lower heart rate while at rest and faster heart rate recovery. This is one of the main indicators of improvement in cardiopulmonary function in athletes (Ito, 2019). . Physiological changes are more profound for high-intensity training programs compared to moderate intensity programs since the former stresses the bodily systems to a greater extent than the latter (Mallikarjuna et al., 2025). Cardio-respiratory fitness is one of the main determinants in the endurance of Football players. Even though this is the case, most university Football players lack proper training approaches that can target cardio-respiratory fitness. It is widely known that HICT training improves cardio-respiratory fitness of athletes but it is not clear about the impacts of this type of training in university Football players. This study aims at bridging the existing gap by examining the effects of HICT training on cardiorespiratory fitness of university Football players, which was help improve training methods and consequently, the performance of the players. Thus, the aim of this study is to investigate the effects of high intensity continuous running training.

1.1. Objectives

Following were the objectives of the study.

1. To determine the effect of high-intensity continuous running training on VO₂ max on the university Football athletes.
2. To determine the effect of high-intensity continuous running training on heart rate recovery on the university Football athletes.
3. To evaluate the effect of high-intensity continuous running training on respiratory function (force vital capacity and force expiratory volume) on the university Football athletes.

1.2. Hypotheses

The following hypotheses were formed for this research study:

- **H1A:** There will be a significant effect of high intensity continuous running training on VO₂ max among university football players.
- **H1B:** There will be significant effect of high intensity continuous running training on Heart Rate Recovery among university football players.
- **H1C:** There will be a significant effect of high intensity continuous running training on force vital capacity and force expiratory volume among university football athletes.

2. Materials and Methods

2.1. Place of work and facilities available

This proposed study was executed at The University of Kamalia, District Toba Tek Singh.

2.2. Plan of work and methodology adopted

The design of this study was experimental, and a systematic approach was adopted to find out the cardiorespiratory fitness results after employing 8 weeks of HICRT treatment on university Football players

2.3. Parameters/variables studied

The following variables were included in the study

2.3.1. Independent Variables

The High intensity continuous training was the independent variable of this study.

2.3.2. Dependent Variables

Maximum oxygen uptake (VO₂max), heart rate recovery (HRR) and respiratory functions were the dependent variables of this study.

2.4. Methods of data collection

For the present research study 40 volunteer male Football players from the University of Kamalia, District Toba Tek Singh were recruited, and divided into two groups, experimental and control group. Each group comprised of 20 male Football players. Eight weeks of HICRT treatment protocol designed by Soylu et al., (2021), was given to the experimental group. Pre-test data recorded from both groups, and after 8 weeks of HICRT treatment post-test data (VO₂max, FVC, FEV₁ and HRR) were again collected from both experimental and control group to evaluate the effects of HICRT on cardiorespiratory fitness of university male students. VO₂ max was assessed using the 20-meter shuttle run test. Respiratory functions including FVC and FEV₁ were measured through a digital spirometer following standard pulmonary testing procedures. Heart Rate Recovery (HRR) was measured after the Yo-Yo Intermittent Recovery Test Level 1. Heart rate was recorded using a Polar H10 chest strap at exercise termination (HR₁), and at 60s (HR₆₀) and 120s (HR₁₂₀) during passive standing recovery.

2.5. Sample size

The sample size for this study consisted of 40 volunteer Football players from The University of Kamalia, District, Toba Tek Singh.

2.6. Sampling technique and procedure

2.6.1. Inclusion Criteria

Male Football players' from The University of Kamalia who are enrolled there aged 18 to 24 years were included in the study.

2.6.2. Exclusion Criteria

The following were excluded from the study,

- Subjects with a history of cardiovascular or respiratory diseases.
- Subjects who were unable to commit to the full duration of the training program.
- The players currently involved in other structured training programs was excluded from the study.

2.7. Statistical analysis/test used

Paired Sample t-test: The use of paired sample t-tests to compare pre- and post-training measurements is appropriate for assessing the effectiveness of the high intensity continuous training intervention. The inclusion of p-values, means, and standard deviations helps readers understand the statistical significance and magnitude of the effects.

3. Results

Table 1: Anthropometric Pre data measurement of Control Group

	N	Min	Max	Mean	SD
Age (year)	20	18.00	24.00	20.85	1.98
Stature (cm)	20	153.00	163.10	159.07	2.88
Weight (kg)	20	46.40	54.80	51.15	2.70
BMI	20	19.30	20.80	20.16	0.42

BMI = Body Mass Index **Min**=Minimum **Max**=Maximum **SD**= Std. Deviation

Table 1 represented the age, stature, weight and BMI measurement of 20 football athletes control group pre data.

Table 2: Anthropometric Pre data measurement of Experimental Group

	N	Min	Max	Mean	SD
Age (year)	20	18.00	24.00	20.85	1.98
Stature (cm)	20	154.50	162.20	159.18	2.25
Weight (kg)	20	45.00	52.00	49.05	2.16
BMI	20	18.50	20.20	19.40	0.40

BMI = Body Mass Index **Min**=Minimum **Max**=Maximum **SD**= Std. Deviation

Table 2 represented the age, stature, weight and BMI measurement of 20 football athletes control group post data.

Table 3: Paired sample t-test of Control Group pre and post data

Group Statistics							
Variable	Group	N	Mean	Std. Deviation	T	df	Sig (2-tailed)
VO ₂	Control Pre	20	39.90	1.41	6.160	19	.811
	Control Post	20	39.88	1.75			
HHR	Control Pre	20	25.60	1.23	3.559	19	.520
	Control Post	20	25.40	1.22			
FVC	Control Pre	20	3.82	0.13	3.943	19	.313
	Control Post	20	3.87	0.14			
FEV ₁	Control Pre	20	3.12	0.14	3.199	19	.110
	Control Post	20	3.16	0.15			

The physiological variables VO₂, heart rate recovery, force vital capacity and force expiratory volume of the pre-intervention and post-intervention of control groups were compared using a Paired Samples t-test. According to the findings, the control group's VO₂ was M±SD=39.90±1.41, HHR M±SD=25.69±1.23, FVC M±SD=3.82±0.13 and FEV₁ M±SD=3.12±0.14 before the intervention and after the intervention VO₂ M±SD=39.88±1.75, HHR M±SD=25.40±1.22, FVC M±SD=3.87±0.14 and FEV₁ M±SD=3.16±0.15 was measured. There was no statistically significant difference in the variables, according to the t-test results (t (6.160, 3.559, 3.943, 3.199), p = .811, .520, .313, .110. We are unable to reject the null hypothesis since the p-value (p = .811, .520, .313, .110) is higher than the 0.05 alpha threshold. This suggests that there is no significant change in these variables after 8-week high intensity continuous running training in the control group from pre-intervention to post-intervention.

Table 4: Paired sample t-test of Experimental Group pre and post data

Group Statistics							
Variable	Group	N	Mean	Std. Deviation	T	df	Sig (2-tailed)
VO ₂	Ex Pre	20	40.05	1.66	24.852	19	.000
	Ex Post	20	46.65	2.36			
HHR	Ex Pre	20	25.75	1.25	30.731	19	.002
	Ex Post	20	19.25	1.44			
FVC	Ex Pre	20	3.81	0.12	22.938	19	.001
	Ex Post	20	4.41	0.14			
FEV ₁	Ex Pre	20	3.12	0.15	28.596	19	.002
	Ex Post	20	3.79	0.15			

The physiological variables VO₂, heart rate recovery, force vital capacity and force expiratory volume of the pre-intervention and post-intervention of experimental groups were compared using a Paired Samples t-test. According to the findings of 8-

week high intensity continuous running training, the experimental group's VO₂ was $M \pm SD = 40.05 \pm 1.66$, HRR $M \pm SD = 25.75 \pm 1.25$, FVC $M \pm SD = 3.81 \pm 0.12$ and FEV₁ $M \pm SD = 3.12 \pm 0.15$ before the intervention and after the intervention VO₂ $M \pm SD = 40.65 \pm 2.36$, HRR $M \pm SD = 19.25 \pm 1.44$, FVC $M \pm SD = 4.41 \pm 0.14$ and FEV₁ $M \pm SD = 3.79 \pm 0.15$ was measured. There was a statistically significant difference in the variables, according to the t-test results ($t(24.852, 30.731, 22.938, 28.596)$, $p = .000, .002, .001, .002$). We can accept the alternate hypothesis since the p-value ($p = .000, .002, .001, .002$) is less than the 0.05 alpha threshold. This suggests that there is a significant change in these variables after 8-week high intensity continuous running training in the experimental group from pre-intervention to post-intervention.

4. Discussion

The present study was conducted to investigate the effects of High-Intensity Continuous Running Training (HICRT) on selected physiological variables among university football players. Football is a physically demanding sport that requires well-developed cardiovascular endurance and respiratory efficiency (Bahtra et al., 2023; Cheng et al., 2025). Therefore, all these physiological parameters are essential for athletic performance to enhance maximum oxygen uptake (VO₂max), heart rate recovery (HRR), as well as forced vital capacity (FVC) and forced expiratory volume (FEV₁). The 8-week pre- and post-intervention high-intensity continuous running training protocol was used to determine the effectiveness on physiological characteristics (Chmura et al., 2023; Clemente et al., 2021).

There were total 40 male university football athletes selected from The University of Kamalia, District Toba Tek Singh, and they were divided into two groups: experimental and control, which included 20 athletes each. After that, the control group continued their routine and regular training activities throughout the 8 weeks, while on the other side the experimental group performed a special High-Intensity Continuous Running Training Protocol under the supervision of university coaches. For checking the normality of data before applying the statistics, Kolmogorov-Smirnov and Shapiro-Wilk tests were used. After obtaining significant data which were representative of normal distribution, independent sample t-test and paired sample t-test were selected to examine the intervention between the groups (Engel et al., 2018).

The findings of the present study revealed that there were no significant changes in VO₂ max, HRR, FVC, and FEV₁ among the control group participants from pre-test to post-test. The mean values remained almost unchanged, and the obtained p-values were greater than the significance level of 0.05. These findings indicate that regular physical activities without structured high-intensity training are insufficient to induce significant physiological adaptations (García-Ortega et al., 2023; Harper et al., 2019). The absence of significant changes in the control group further strengthens the effectiveness of the intervention applied to the experimental group.

5. Conclusion

Based on the results obtained and analyzed, the following conclusions were drawn:

VO₂ max improvement: 8-weeks high intensity continuous running training protocol had significantly improved aerobic capacity of football athletes. After increasing the VO₂ values, which reflected better utilization and better oxygen uptake for sustaining the high-performance during football matches.

Heart rate recovery: Subjects showed quick heart rate recovery after taking the high intensity continuous training protocol post intervention. This indicates improved greater cardiovascular efficiency, autonomic cardiac regulation and allowing players to recover quicker between high intensity bouts on the field.

Pulmonary function: It is suggested that force vital capacity and force expiratory volume provide stronger muscles capacity, lungs efficiency and prolonged physical exertion and reduce the fatigue. HICRT proves that to enhanced positive adaptation in force vital capacity as well as force expiratory volume. Pulmonary function force vital capacity and expiratory volume suggested being improved.

5.1. Recommendations

Taking into consideration the results of the current research, which revealed that High-Intensity Continuous Running Training (HICRT) was significantly effective in improving the VO₂max, heart rate recovery (HRR), forced vital capacity (FVC), and forced expiratory volume in one second (FEV₁) of university footballers during an eight-week training period, the following recommendations can be made by sports scientists, coaches, athletes, and policymakers. The recommendations are aimed to implement the results of this research and apply them to improve football performance in universities and beyond.

5.1.1. Recommendations for Coaches and Trainers

It is important for coaches and instructors to incorporate conditioning programs; consequently, HICRT is highly suggested for systematic inclusion in the training program of university football teams. The findings of the current study indicate that physical

activity done in the absence of high-intensity stimulation does not result in substantial changes in the cardiorespiratory system. The HICRT modality must be included in the pre- and in-season macrocycles. Specifically, during the pre-season, 4 training sessions per week, ranging from 30 to 45 minutes in duration and performed at 80–90% HRmax are advised in order to lay down a solid aerobic foundation. In the season of competition, this frequency can be decreased to 2–3 sessions without causing excessive fatigue.

Intensity monitoring should be done using heart rate monitors, GPS tracking devices, and rating of perceived exertion (RPE) scales. The target heart rate zone for each player should be determined through VO₂max testing of the individuals. This way, the players will be subjected to the desired level of intensity for stroke volume, capillary density, and mitochondrial adaptations. Hence, due to the high pressure that HICRT imposes on the cardiovascular system, proper recovery periods of 24–48 hours between the high intensity phases must be provided for. It is necessary that the coaches stress upon active recovery, hydration, and proper sleep practices to maximize the effects on the parasympathetic nervous system. The sports departments of universities should organize workshops regularly to train coaches on current methods of endurance training, pulmonary function evaluation, and recovery methods. This would bring about the connection between sports science research and its application in the field.

5.1.2. Recommendations for Athletes

Athletes must recognize that physiological superiority in football is achieved through consistency, discipline, and self-monitoring, not merely through technical drills.

Athletes are advised to maintain consistency in high-intensity running sessions during both pre-season and in-season phases. Detraining can lead to rapid decline in VO₂max and pulmonary function. Even during off-season breaks, at least two maintenance sessions per week are recommended. Regular self-assessment through periodic VO₂max testing (e.g., Yo-Yo Intermittent Recovery Test Level 2, Cooper Test, or lab-based treadmill test) and daily morning resting heart rate and HRR tracking can help athletes understand their adaptation status.

5.1.3. Recommendations for Strength and Conditioning Programs

A holistic conditioning approach is essential for reducing injury risk and ensuring balanced physical development in football players. It is advised to incorporate HICRT alongside resistance exercises. There is an exercise regimen that combines resistance training (two times a week targeting lower limb strength, core stability, and plyometrics) and HICRT on alternate days. This model will lead to enhanced levels of aerobic capacity and muscular power without interference. To combat the rigidity that could potentially arise from constant running, mobility exercises and dynamic stretches should be incorporated to preserve flexibility and increase running efficiency.

5.1.4. Recommendations for Sports Scientists and Future Researchers

The current research has been delimited to 40 male university players from one university with an 8-week intervention. The suggestions for future research aimed at improving the generalizability and scientific value of research findings include:

Future studies should evaluate the effect of HICRT throughout the entire competitive season lasting between 6 and 9 months in order to measure potential adaptations, detraining effects, and retention of cardiorespiratory improvements. Additional research needs to be conducted in comparing HICRT with high-intensity interval training (HIIT), Fartlek training, and small-sided games in order to develop effective training prescription for the different physiological outcomes in football. Further investigation needs to involve both women and men from different age groups (U-17, U-21, senior) and elite professionals. Besides VO₂max, HRR, FVC, and FEV₁, future studies need to involve additional variables, including lactate threshold, running economy, VO₂ kinetics, maximal voluntary ventilation (MVV), and heart rate variability (HRV). Integration of biochemical markers like hemoglobin and myoglobin levels, measures of stroke volume using echocardiography, and measurement of inspiratory muscle strength using spirometry will help gain further mechanistic understanding. Utilization of wearable devices, GPS, and portable spirometry in future research can help gain ecologically valid information from real-life match-play situations. Inter-university cooperation in Punjab as well as other provinces should be encouraged to increase the sample size and generalizability of the findings.

5.1.5. Recommendations for University Sports Departments and Policymakers

From an institutional perspective, some actions must be taken to convert scientific approaches into policy:

The universities must design specific courses, laboratories for physiological testing including VO₂max and pulmonary function tests, and recovery units. The absence of such facilities is usually the reason for failure to introduce scientific training approaches at the university level in Pakistan.

5.2. Practical Implications and Conclusion

Practically, the current research offers clear proof that an 8-week HICRT program represents a highly effective, resource- and time-saving tool of enhancing physiological factors of football fitness performance. In contrast to equipment-based exercises that are quite costly, continuous running demands limited resources and thus can be performed at universities. Increase in VO₂max level by 16.5% (up to 46.65 ml/kg/min), decrease in HRR time, and increase in FVC and FEV₁ levels by 15-21% indicate the influence of HICRT training on enhancement of oxygen transport (hemodynamic parameters, hemoglobin, capillary density) and oxygen usage (activity of enzymes in mitochondria, arteriovenous difference in oxygen content) as well as ventilatory capacity (respiratory muscles strength, compliance of lungs).

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