EFFECT OF INTERVAL AND CONTINUOUS TRAINING ON VO2MAX AMONG COLLEGE LEVEL FOOTBALL PLAYERS-A COMPARATIVE STUDY.

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ABSTRACT : Background: Football is a high-intensity endurance sport that requires high level of anaerobic power, aerobic capacity, speed, muscular strength, agility and flexibility. The continuous running and interval training methods are more common and applied extensively by football coaches during preparatory period to improve the endurance ability of players. Considering that the studies are there to prove that cardiovascular parameters vary by training. This study will help us to evaluate the change in vo2max in college level football players by interval and continuous training thus it will lead to a better understanding of the difference in the interval and continuous training and their effect on vo2max and will also help us to plan a specific training program for college level football players. **Objective:** To compare the effectiveness of interval and continuous training on vo2max among college level football players. **Material And Methodology:** Subjects were taken from my college institute. The subjects selected for the study is randomized into two groups by using Simple random sampling using computer generated random numbers method. **Group-A** (Interval training Group) and **Group-B** (Continuous training Group). The Treatment duration was 3 sessions per week for 6 weeks. The outcome measures taken were Vo2max. **Results:** Results showed that there was statistically significant change in Vo2max between Groups-A and B. **Conclusion:** The study concluded that interval training is more effective than continuous training in improving Vo2max in college level football players.

Key Words: Football, Interval training, Continuous training, Cardiovascular parameters

I. INTRODUCTION

Football is a high-intensity endurance sport that requires intermittent and random bouts of powerful anaerobic activities such as sprints, rapid acceleration and deceleration, turning, jumping, kicking, and tackling[1,2]. It is usually presumed that through the years, this game has developed to become faster, with more intensity and aggressive play[3].

Professional football is a difficult sport in which various activities such as fast sprints, kicks and tackles are done in succession[4].It requires peak physical conditioning of its players to be played at the highest level.

Based on various research results, physical and physiological characteristics of football players are required to such a high level of anaerobic power, aerobic capacity, speed, muscular strength, agility and flexibility[5,6,7,8]. Out of all the skills, the most important skill in football is aerobic endurance[9]. Aerobic endurance has capability to perform work for a longer period of time in conditions of aerobic metabolism[10].

To compete in modern sports to concentrate on physical, physiological and technical preparation on a long term basis. The Physical fitness is always regarded as the fundamental tool to get the best possible results in football game. All physical fitness components are equally essential to perform at top level but the role of endurance ability is always considered very basic and important factor in football[11].

The question that still remains unknown in the literature is the structure of training models and their long term impact on player's physical fitness. In fact, in order to meet the specificity principle of training, it seems that training models should be based on competition physiological determinants and, practices should prepare players to respond adequately to these requirements[12].The advantages of the training vary from better performance while on pitch for prolong period to a less chance of injury or cramping before, during and after match. Also, a better conditioned player is more likely to perform with the same amount of skill required when passing, dribbling and shooting at the end of the game as the beginning[13].

Commonly used exercises include plyometrics, resistive training and various forms of intermittent training[14,15]. A worldwide continuous running, interval training, shuttle run and fartlek training methods are used to improve the endurance ability of team game players but in India, specifically continuous running and interval training methods are more common and applied extensively by football coaches during preparatory period to improve the endurance ability of players[11].The continuous running and interval training are the well established methods which considerably improve the endurance ability (aerobic and anaerobic) of players[11,16].

Continuous training, also known as continuous exercise, is any type of physical training that involves activity without rest intervals. Continuous training can be performed at low, moderate, or high exercise intensities,[17] Exercise modes noted as suitable for continuous training include indoor and outdoor cycling, jogging, running, walking, rowing, stairclimbing, simulated climbing, Nordic skiing, elliptical training, aerobic riding, aerobic dancing, bench step aerobics, hiking, in-line skating, rope skipping, swimming, and water aerobics[18].

Interval training is a physical training involving bursts of high-intensity work interspersed with periods of low-intensity work. The high-intensity periods are typically at or close to near-maximum exertion, while the recovery periods may involve either complete rest or activity of lower intensity. Interval training provides benefits to any healthy person such as improving fitness, health, speed and stamina; it's a very demanding type of activity and certainly not one you would want to fly into without adequate preparation.[1]

The maximal oxygen uptake (VO_2 max) is the highest possible oxygen uptake that a given subject can achieve for a given form of ergometry. Maximal oxygen uptake may be determined by repeated studies at higher and higher work rates to determine the highest possible value, or the VO_2 max can be accepted when VO_2 reaches a plateau during a single maximum work rate test[13.]

The maximum VO_2 (VO_2 max) reflects the attainment of a limitation at some point(s) in the oxygen conductance pathway from lungs to the site of mitochondrial oxygen consumption at cytochrome-oxidase terminus of the electron transport chain. This, dysfunction in the responses of the convective oxygen flows into the lungs and through the vasculature and the diffusive oxygen flows across pulmonary and muscle capillary beds will be reflected in abnormally low values of VO_2 max[19.]

The increase in maximal oxygen uptake (VO2max) causes an increase in stroke volume of the heart, which results in increased cardiac output (the maximum amount of blood ejected by the heart into the bloodstream in one minute)[20]. (Tanisho & Hirakawa, 2009; Vucetic V. & Šentija, 2004).

The rate of perceived exertion (RPE) when properly assessed during exercise can be used to identify the end point of maximum effort. The Borg perceived exertion scale provides reproducible measures of effort[21.]Maximal heart rate varies greatly among individuals during exercise testing. Therefore, it is helpful to be able to evaluate rates of perceived exertion to assess whether or not a test is truly maximal and to assess when maximum exercise is being approached. Numerous clinical studies have demonstrated that the category RPE scale is reproducible measure of exertion within a wide variety of individuals regardless of age, gender and culture. During most exercise testing, the category RPE scale is an accurate gauge of impending fatigue[22.]

Heart rate is one of our vital signs – represented as the number of times a minute that our heart contracts or beats. Increased heart rate is responsible for the majority of cardiac output augmentation during exercise. The heart rate goes up with exertion - the purpose of which is to deliver more oxygen and energy for the activity. The heart rate is how many times a minute that our arteries expand and contract in response to the heart. The rate of heart contractions cause the increases in blood pressure and the pulse in the arteries. Taking the pulse, therefore, is a direct measure of heart rate. Resting heart rate, which is the rate at which our heart beats when we are relaxed[23]. Heart rate (HR) is mediated primarily by the direct activity of the autonomic nervous system (ANS), specifically through the sympathetic and parasympathetic branches activities over the sinus node autorhythmicity, with predominance of the vagal activity (parasympathetic) at rest, that is progressively inhibited since the onset of the exercise. Individuals with high levels of aerobic condition have a lower resting HR, along with a larger parasympathetic activity or smaller sympathetic activity. The HR response in the onset of the exercise represents the integrity of the vagus nerve, and the HR recovery on the post-exercise transient also denotes important prognostic information[24].

Rate pressure product: Interaction between several mechanical factors-most importantly, the development of tension within the myocardium and its contractility, and heart rate determine myocardium oxygen consumption. With increases in each of these factors during exercise, myocardium blood flow adjusts to balance oxygen supply with demand. One common estimate of myocardial workload (and resulting oxygen) uses the product of peak systolic blood pressure (SBP), measured at the brachial artery, and heart rate (HR).

This index of relative cardiac work, termed the double product or rate pressure product (RPP), relates closely to directly measure myocardial oxygen consumption and coronary blood flow in healthy subjects over a wide range of exercise intensities.

RPP computes as follows $RPP=SBP \times HR$. Changes in heart rate and blood pressure contribute equally to changes in RPP. The RPP provides an objective yard stick to evaluate the effects on cardiac performance of various clinical, surgical interventions. The well documented lowering of exercise H.R and SBP (hence lower RPP and myocardial oxygen requirement) with training helps to explain the improved exercise capacity[25.]

Considering that the studies are there to prove that cardiovascular parameters vary by training. This study will help us to evaluate the change in cardiovascular parameters in college level football players by interval and continuous training thus it will lead to a better understanding of the difference in the interval and continuous training and their effect on cardiovascular parameters. This study will also help us to plan a specific training program for college level football players.

II. MATERIALS AND METHOD

The study was approved by Institutional ethical committee.

STUDY DESIGN:
It is a Randomized Control Trial

STUDY SETTING:
This Study Was Conducted At Gymnasium of our college institute.

STUDY DURATION:
The total duration of the study is 6weeks. (3 times a week for 6 weeks)

SAMPLE SIZE:
Based on standard deviation of (SD) 52.8, a sample size of 8 players per group provides a 80% power to detect an effect on cardiovascular parameters assuming a significance level of 0.05. Sample size was calculated using Graph pad Stat mate v2.0. The sample size of 52 (fifty-two) players were divided into two groups:
Group A: (n=27) Interval training Group.
Group B: (n=25) Continuous training Group.

SAMPLE DESIGN: Simple random sampling using computer generated random numbers.

INCLUSION CRITERIA :
1. Age group of 18 to 25 years
2. Male Football players, playing since last 2 years.
3. Subjects willing to participate in the study.
4. Subjects who are able to read and write English
5. Subjects able to understand commands.

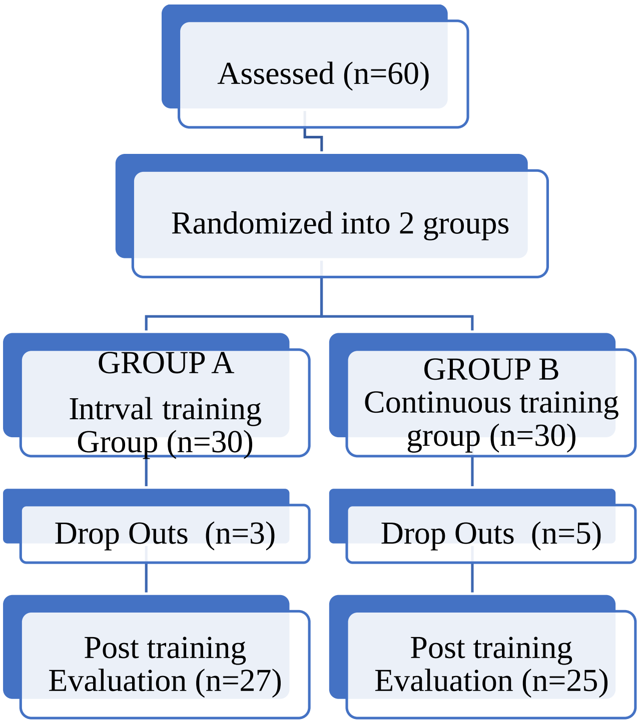
EXCLUSION CRITERIA:
1. Presently having any kind of injury in lower limb.
2. Any musculoskeletal disorders, neurogenic disorders, cardiovascular, respiratory, heamatological or endocrine disorders.
3. Subjects having a history of upper limb or lower limb pain or trauma that had required treatment or interrupted their normal daily activities.
4. Previously undergone any surgery (last 6 months).
5. Subjects having acute or chronic abnormal pain related to surgical or medical illness, smokers, alcoholics or those receiving psychiatric treatment.
6. Players who are indulge in any kind of exercise or fitness program during the study.

MATERIAL USED IN THE STUDY:
1. Consent form
2. Evaluation sheet
3. Modified Borg scale
4. Tredmill
5. Sphygmomanometer
6. Pulse oxymeter
7. Stethoscope
8. Stopwatch
9. Digital camera
10. Pen, paper, pencil

OUTCOME MEASURE:
- Vo2max
- RPE(The rate of perceived exertion)
- HR(Heart rate)
- RPP(Rate pressure product)

III. PROCEDURE:

Subjects were taken from my college institute. Players were screened and after finding their suitability as per inclusion and exclusion criteria 60 subjects are included. The subjects selected for the study is randomized into two groups by using Simple random sampling using computer generated random numbers method. **Group-A** (Interval training Group) and **Group-B** (Continuous training Group)



The prior consent of the players were taken. The Initial evaluation of the subjects were done. The outcome measure Vo2 max was calculated by using Astrand protocol. Rate of perceived exertion was evaluated using category (C) ratio (R) scale, the Borg CR10 Scale. Heart rate and Systolic blood pressure were checked by using pulse oxymeter and sphygmomanometer respectively.
Training duration: 3 sessions per week for 6 weeks.

ASTRAND PROTOCOL:

- Subjects begin to run on treadmill for 10 minutes warm up
- After that set the Treadmill at 5 mph (8 kph), with the gradient at 0%
- After 3 minutes, the gradient is increased to 2.5% (1.4)
- Every two minutes thereafter, the gradient is increased by 2.5%
- The stopwatch was stopped and the time was recorded when the player is unable to continue
- From the total running time an estimate of the player's VO_2 max was calculated by formula:
- VO_2 max = (Time × 1.444) + 14.99
- (Where "Time" is the total time of the test expressed in minutes and fractions of a minute) [36,37].

TRAINING PROTOCOLS:
Group A: Interval training group:
Time duration: 40mins.
Interval Training subjects warmed up for 10 minutes at 70% of maximal heart frequency (HRmax) after that four 4-minute intervals at 90% of (HRmax) and in between the interval, a 3-minute active recovery at 70% of (HRmax) and it ends with 5 minute of cool down period[53].
Group B: Continuous training group:
Time duration: 47 minutes.
Continuous training group had to exercise at 70% of (HRmax) at each exercise session as to equalize similar amounts of kilocalories per session in the 2 groups[53].
Heart frequency was continuously monitored during exercise to ensure that the subjects trained at the intended intensity.
After 6 weeks of intervention, the outcome measure Vo2 max was calculated by using Astrand protocol. Rate of perceived exertion was evaluated using category (C) ratio (R) scale, the Borg CR10 Scale. Heart rate and Systolic blood pressure were checked by using pulse oxymeter and sphygmomanometer respectively. Appropriate statistical test was used to compare the data between the groups to determine the effectiveness between two groups at the end of 6 weeks. Level of significance was kept 0.05.
DESCRIPTION OF OUTCOME MEASURES :
1. VO2 Max:
In assessing cardio fitness, VO2 max is widely considered the gold standard measurement, and a key indicator of fitness in endurance events. The Astrand test is used to measure a subjects aerobic fitness, specifically it is a predictive test of the VO2max. It requires the subject to run as long as possible on a treadmill whose slope increments at timed intervals
VO_2 max = (Time × 1.444) + 14.99.
(Where "Time" is the total time of the test expressed in minutes and fractions of a minute) [36,37].

2 .The Rate of perceived exertion (RPE):
In sports and particularly exercise testing, the Borg Rating of Perceived Exertion (RPE) Scale measures perceived exertion. In sports coaches use the scale to assess the intensity of training and competition. It is helpful to evaluate rates of

perceived exertion to assess whether or not a test is truly maximal and to assess when maximum exercise is being approached[43]. The original scale introduced by Gunnar Borg rated exertion on a scale of 6-20. Borg then constructed a category (C) ratio (R) scale, the Borg CR10 Scale. The Borg CR10 Scale is more useful for statistical analysis than the Borg RPE[44]. The reliability of the Borg CR10 Scale is 0.83[69].

3. Heart rate:

It is the speed of the heartbeat measured by the number of contractions of the heart per unit of time, typically beats per minute (bpm). The heart rate can vary according to the body's physical needs, including the need to absorb oxygen and excrete carbon dioxide. Activities that can provoke change include physical exercise, sleep, anxiety, stress, illness, ingesting, and drugs.

The heart rate goes up with exertion - the purpose of which is to deliver more oxygen and energy for the activity. Resting heart rate, which is the rate at which our heart beats when we are relaxed. The normal resting adult human heart rate ranges from 60–100 bpm[45]. Pulse oximeters are often used for estimating heart rate at rest and during exercise. The reliability of pulse oxymeter is 0.93[70].

4.Rate pressure product:

Rate pressure product is a measure of the stress put on the cardiac muscle based on the number of times it needs to beat per minute (HR) and the arterial blood pressure that it is pumping against (SBP). It will be a direct indication of the energy demand of the heart and thus a good measure of the energy consumption of the heart. Rate pressure product allows you to calculate the internal workload or hemodynamic response.

It computes as follows RPP=SBP × HR.

The auscultatory method (from the Latin word for "listening") uses a stethoscope and a sphygmomanometer. This comprises an inflatable cuff placed around the upper arm at roughly the same vertical height as the heart, attached to a mercury or aneroidmanometer. A cuff of appropriate size is fitted smoothly and also snugly, then inflated manually by repeatedly squeezing a rubber bulb until the artery is completely occluded. Listening with the stethoscope to the brachial artery at the antecubital area of the elbow, the examiner slowly releases the pressure in the cuff. When blood just starts to flow in the artery, the turbulent flow creates a "whooshing" or pounding (first sound). The pressure at which this sound is first heard is the systolic blood pressure[71]. The auscultatory method is the predominant method of clinical measurement[72].

Changes in heart rate and blood pressure contribute equally to changes in RPP. This index of relative cardiac work, termed the double product or rate pressure product (RPP), relates closely to directly measure myocardial oxygen consumption and coronary blood flow in healthy subjects over a wide range of exercise intensities[25].

IV. RESULTS

In present study 52 subjects with the age group of 18-25 years were taken and divided into two groups. Group A (Interval training) and Group B (Continuous training). 52 individuals completed the study program without any complications. The data obtained in both the groups are as follows. Statistical Package for Social Sciences [SPSS] v20 was used for the data analysis.

In present study the level of significance was kept at 5%. Normality test was performed using SPSS v20 and data was not found to be normally distributed.

To analyze the effects on the outcome measure Vo2max, RPE(Rate of perceived exertion), HR(heart rate),RPP(Rate pressure product) between the two groups A and B, Man Whitney U test was used.

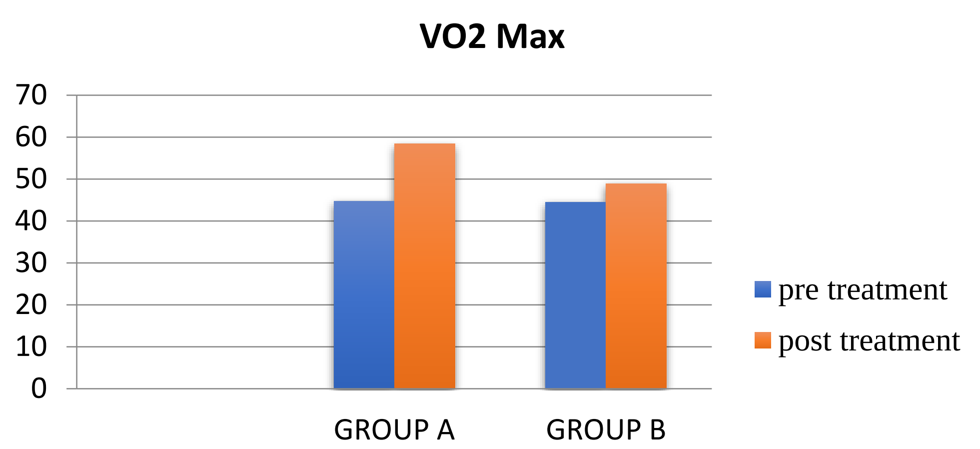
Table 1: Tests used to compare outcome measures between Groups

Outcomes	Test used to compare within Group A	Test used to compare within Group B	Test used to compare between Group A and B
Vo2max,	Wilcoxon Signed Rank test	Wilcoxon Signed Rank test	Man Whitney U test
HR(heart rate)	Wilcoxon Signed Rank test	Wilcoxon Signed Rank test	Man Whitney U test
RPE(rate of perceived exertion)	Wilcoxon Signed Rank test	Wilcoxon Signed Rank test	Man Whitney U test
RPP(rate pressure product)	Wilcoxon Signed Rank test	Wilcoxon Signed Rank test	Man Whitney U test

Table 2: Mean Difference in vo2max in Group A and Group B
(Mean and Standard Deviation)

Group	Pre treatment		Post treatment		Z value	P value
	Mean	±SD	Mean	±SD		
Group A- Interval training	44.74	2.50	58.36	1.76	-4.541	0.0001
Group B- Continuous training	44.49	2.40	48.90	1.94	-4.292	0.0001

Here, Wilcoxon Signed Rank test was performed for the analysis. For Group A, p-Value is <0.0001 and for Group B, p-Value is <0.0001 which was highly significant.

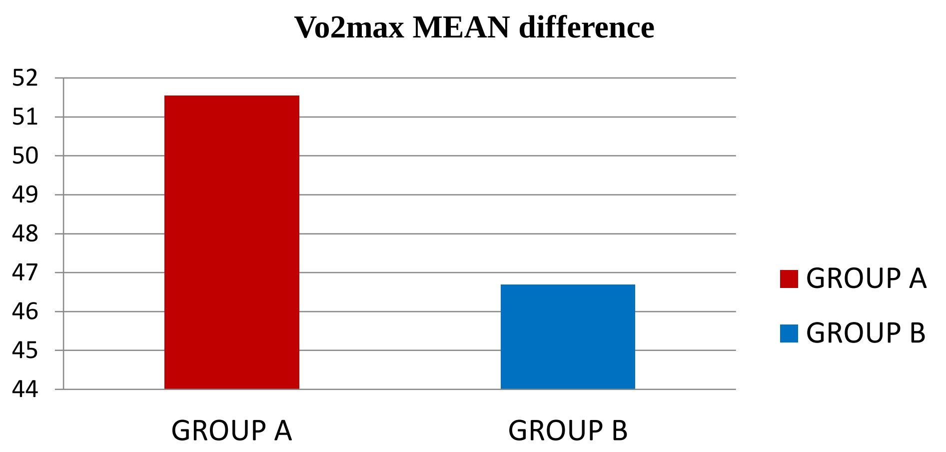


Graph 1: Mean Difference in vo2max in Group A and Group B

Table 3: Mean Difference in vo2max between Group A and Group B
(Mean and Standard Deviation)

	Group A	Group B	U- Value	p-Value
Mean	51.55	46.69	16.500	0.0001
± SD	1.82	1.58		

Here, the Man Whitney U test was used for analysis and p-value is <0.001 between the group A and B. Here, it shows highly significant difference.

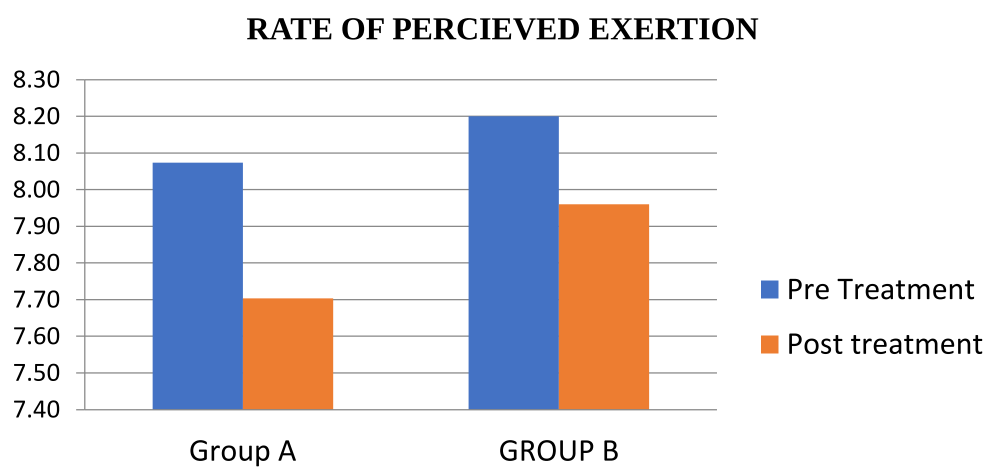


Graph 2: Mean Difference in Vo2max score between Group A and B

Table 4: Mean Difference in RPE in Group A and Group B (Mean and Standard Deviation)

Group	Pre treatment		Post treatment		Z value	P value
	Mean	±SD	Mean	±SD		
Group A-Interval training	8.07	.474	7.70	.609	-2.500	0.012
Group B-Continuous training	8.20	.500	7.96	.539	-2.121	0.034

Here, Wilcoxon Signed Rank test was performed for the analysis. For Group A, p-Value is 0.012 and for Group B, p-Value is 0.034 which was not significant.

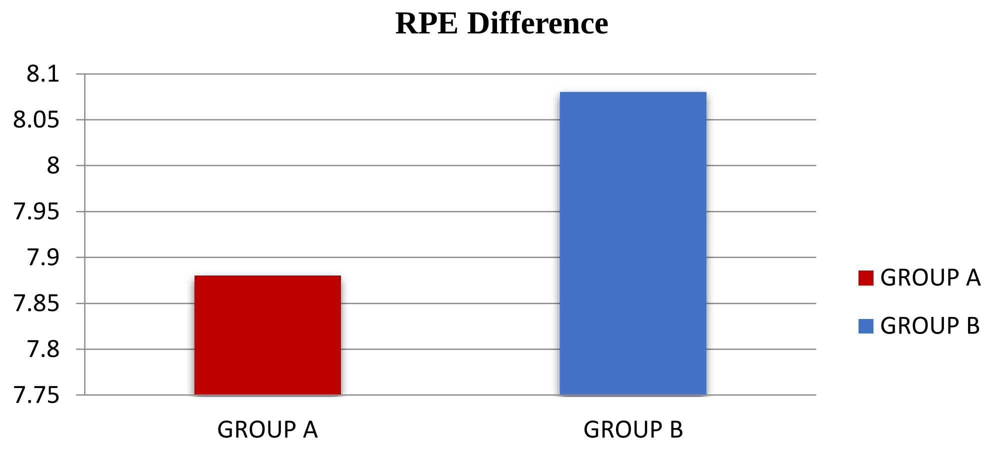


Graph 3: Mean Difference in RPE in Group A and B.

Table 5: Mean Difference in RPE between Group A and Group B (Mean and Standard Deviation)

	Group A	Group B	U- Value	p-Value
Mean	7.88	8.08	264.000	0.143
± SD	0.42	0.44		

Here, the Man Whitney U test was used for analysis and p-value is 0.143 between the group A and B. Here, it shows no significant difference.



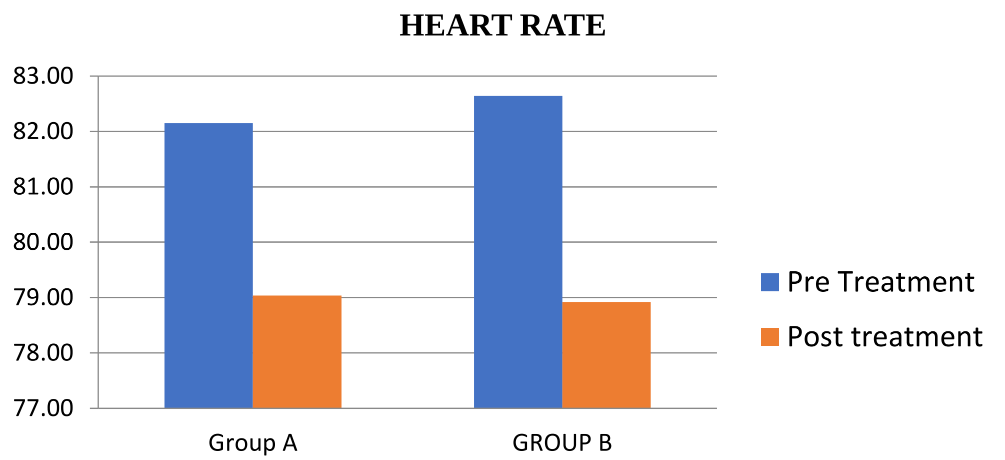
Graph 4: Mean Difference in RPE score between Group A and B

Table 6: Mean Difference in HR in Group A and Group B (Mean and Standard Deviation)

Group	Pre treatment		Post treatment		Z value	P value
	Mean	±SD	Mean	±SD		
Group A- Interval training	82.15	4.083	79.04	3.144	-3.184	0.001

Group B-Continuous training	82.64	3.650	78.92	2.929	-4.192	0.0001

Here, Wilcoxon Signed Rank test was performed for the analysis. For Group A, p-Value is 0.001 which was significant and for Group B, p-Value is <0.0001 which was significant.

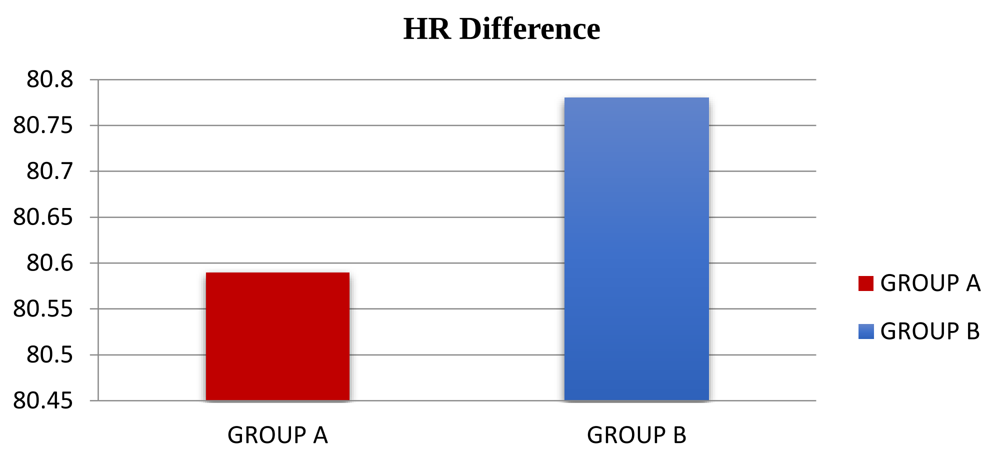


Graph 5: Mean Difference in HR in Group A and B.

Table 7: Mean Difference in HR between Group A and Group B (Mean and Standard Deviation)

	Group A	Group B	U- Value	p-Value
Mean	80.59	80.78	320.500	0.755
± SD	3.01	3.10		

Here, the Man Whitney U test was used for analysis and p-value is 0.755 between the group A and B. Here, it shows no significant difference.

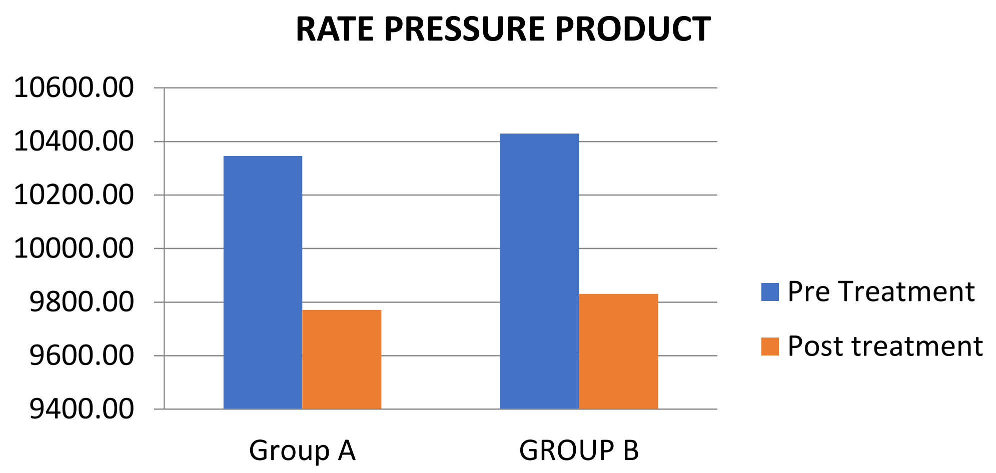


Graph 6: Mean Difference in HR score between Group A and B

Table 8: Mean Difference in RPP in Group A and Group B (Mean and Standard Deviation)

Group	Pre treatment		Post treatment		Z value	P value
	Mean	±SD	Mean	±SD		
Group A-Interval training	10345.56	627.76	9770.15	422.49	-3.436	0.001
Group B-Continuous training	10428.96	457.19	9831.04	454.33	-4.184	0.0001

Here, Wilcoxon Signed Rank test was performed for the analysis. For Group A, p-Value is <0.001 which was significant and for Group B, p-Value is <0.0001 which was significant.

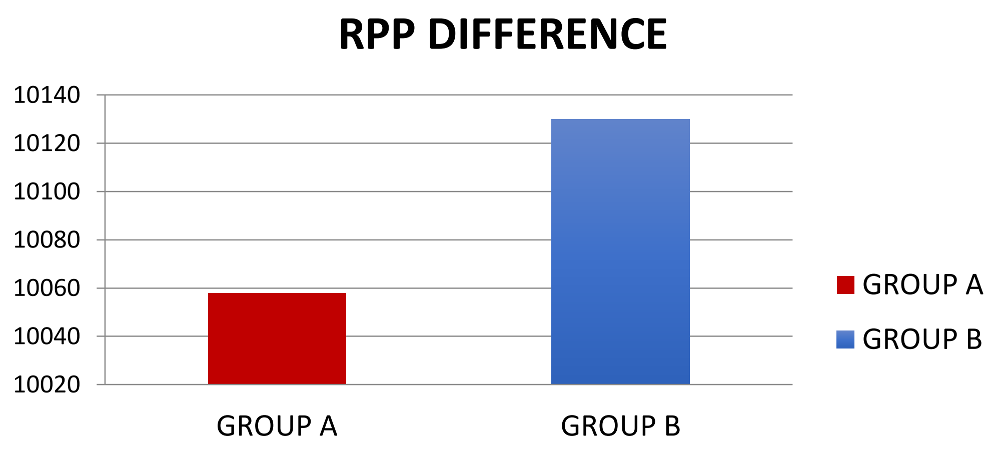


Graph 7: Mean Difference in RPP in Group A and B.

Table 9: Mean Difference in RPP between Group A and Group B (Mean and Standard Deviation)

	Group A	Group B	U- Value	p-Value
Mean	10057.85	10130	306.000	0 .564
± SD	397.05	399.88		

Here, the Man Whitney U test was used for analysis and p-value is 0.564 between the group A and B. Here, it shows no significant difference.



Graph 8: Mean Difference in RPP score between Group A and B

V. DISCUSSION

The main aim of the study is to compare the effectiveness of interval and continuous training on cardiovascular parameters like vo2max, Rate of perceived exertion, Heart rate and Rate pressure product among college level football players. Here 62 individuals were recruited for the study with 32 in one group (Group A) and 30 in other group (Group B) having mean age in Group A= 20.15 and Group B= 20.44.

In Group A, vo2max was taken before and after the treatment. The study showed significant increase in vo2max for Group A (Z= -4.5411, p= <0.0001). Thus the interval training shows the significant improvement in the vo2max among college level football players. The rest period used in the present study had a significant impact on the improvement in aerobic power as the regimen called for the players to have a 3 minute recovery period in interval training , in which time they would run on treadmill to prepare for the next effort. This can be explained accordance to the study done by **Darren E.R. Warburton 2005** which states the Effectiveness of High-Intensity Interval Training for the Rehabilitation of Patients With Coronary Artery Disease.

According to this study, interval training lead to adaptations that allow for a greater tolerance to a strenuous exercise challenge[73,74] and Further the importance of high-intensity training for functional status revealed that this form of training improves cardiac function (including submaximal stroke volume, improved myocardial contractility, and an increased ejection fraction at peak exercise) and exercise tolerance[75,76,77]. Thus, the use of interval training has been established as an effective and efficient method of improving aerobic power in well-trained and youth subjects.

In Group B, vo2max was taken before and after the treatment. The study showed significant increase in vo2max for Group B (Z= -4.292, p= <0.0001). Thus the continuous training shows the significant improvement in the vo2max among college level football players. This can be explained according to the study done by **Kuno Hottenrott et al,2012** the effects of high intensity training and continuous endurance training on aerobic capacity and body composition in recreationally active runners which states that both high-intensity-training and continuous endurance running led to increases of the vo2max[57].

Comparing the mean difference of vo2max between groups A & B showed statistically significant difference (U= 16.500, p= 0.001) at 5% level of significance. Hence, interval training is more effective than continuous training and can be recommended as an effective training to improve Vo2mX. This improvement of Vo2max in the interval training can be explained accordance with the recent study done by **Timothy James,** which states the effect of high intensity running training on work capacity in football .

According to the study they had hypothesized that Aerobic interval training would increase VO2peak more than Moderate continuous training[78]. In this study the recovery protocol may have contributed positively to the results for two reasons. First, the recovery period in the interval training would have meant the anaerobic energy production systems would have inadequate time to fully restore. As a result with each subsequent repetition, the aerobic system would have been called on to make a greater contribution to energy production[79]. If sufficient repetitions of this form of training are performed, energy production from aerobic metabolism will be challenged regularly enough for a training effect to take place[80]. Second, it has been found that a passive recovery is a more effective strategy to adopt when performing supra-maximal HIIT[81]. In both these studies, participants were able to maintain the training intensity and perform greater workloads per effort with a passive rather than active recovery strategy. Due to the high energy demands of supra-maximal interval training, oxygen demands for each subsequent interval is too high for any oxygen to be used in the short recovery period. Thus it can be postulated that the recovery strategy used in the current study contributed to the improvement in aerobic power, as more oxygen was theoretically available for the players to maintain the required intensity[78].

The present study showed statistically no significant difference in Rate of Perceived Exertion(RPE) in Group A (Z= -2.500, p= <0.012) and Group B (Z= -2.121, p= <0.034) .

Comparison the mean difference of Rate of Perceived exertion(RPE) between group A and B showed there was no significant difference between the 2 groups (U= 264.000, p= 0.143) at 5% level of significance. Hence, both the trainings have no significant effect on rate of perceived exertion. This can be explained according to the study done by **David W. Hill** which states the Effect of training on the rating of perceived exertion at the ventilatory threshold. The Ventilatory threshold was that point above which VO2 increased abruptly relative to work rate. The result of this study showed that adjusted means for RPE at the ventilatory threshold were not significantly different (2%). As the RPE represents the athlete's own perception of training stress, which can include both physical and psychological stress, the session-RPE method may provide a valuable measure of internal TL[82].

The present study also showed statistically significant decrease in Heart rate (hr) in Group A (Z= -3.184, p= <0.001) . Group B showed (Z= -4.192, p= <0.0001) statistically significant decrease in heart rate (hr). Thus the interval training and continuos training shows the significant reduction in the heart rate among the college level football players. According to the study done by **Marcos B. Almeida,2003** which states that effects of aerobic training on heart rate explained that Vagal nerve activity (parasympathetic branch) is considered to be a cardiovascular protection factor; therefore, ANS dysfunction, particularly reduction of the cardiac vagal tone, some of the changes that take place in HR control at rest and at exercise submaximal levels are consequence of intrinsic adaptations of the sinus node, or derived from other physiological changes, such as the increase of venous return and systolic volume, and improved myocardial contractility; or peripheral, such as improved oxygen extraction (oxygen arteriovenous difference) or enhanced O2 use to generate more work (mechanical efficiency), causing HR to reduce to those (submaximal) required levels[83]. Also, the another study done by **Kuno Hottenrott et al,2012** the effects of high intensity training and continuous endurance training on aerobic capacity and body composition in recreationally active runners which states that in both groups the resting heart rate was reduced significantly after completing the intervention period[57.]

Comparison between the mean difference of heart rate(hr) group A and B showed there was no significant difference between 2 groups (U= 320.500, p= .755) at 5% level of significance. Hence, both the trainings have no significant effect on heart rate(hr). The study done by **Darren E.R. Warburton,2005** on Effectiveness of High-Intensity Interval Training for the Rehabilitation of Patients with Coronary Artery Disease. In this study (both traditional continuous and interval training) did not result in significant changes in resting measures of heart rate (155 ± 19) v/s (159 ± 15) [65]. RPP (Rate pressure product) was taken before and after the treatment.

The present study showed statistically significant decrease in RPP (Rate pressure product) in Group A (Z= -3.436, p= <0.001). Group B showed (Z= -4.184, p= <0.0001) statistically significant decrease in RPP (Rate pressure product). It can be explained according to the study done by **Gaeini AA, 2015 et al** which states the effects of aerobic continuous and interval training on rate-pressure product in patients after CABG surgery. And it showed a significant decrease in resting and maximal RPP and at 3rd, 6th and 9th minutes of exercise was found in aerobic continuous and aerobic interval training vs control group (p<0.05) [67].

Comparing the mean difference of RPP of Group A and Group B between 2 groups (U= 306.000, p=.564) showed there was no significant difference RPP between 2 groups. The study done by **Darren E.R. Warburton,2005** on effectiveness of High-Intensity Interval Training for the rehabilitation of Patients with Coronary Artery Disease. The study stated that both traditional continuous and interval training did not result in significant changes in resting measures of rate–pressure product (25,757 ±4,158) vs (26,888 ±3,989)[68]. Hence, both the trainings have no significant effect on Rate pressure product (RPP).

VI. CONCLUSION

From the result of the present study,

- Null hypothesis (H_{01}) is rejected. Thus, it is concluded that the interval training is more effective than continuous training in improving vo2max in college level football players.
- Null hypothesis (H_{02}) is accepted. Thus it concluded that there is no significant difference in Rate of perceived exertion (RPE) by interval and continuous training in college level football players.
- Null hypothesis (H_{03}) is accepted. Thus, it concluded that there is no significant difference in heart rate (hr) by interval and continuous training in college level football players.
- Null hypothesis (H_{04}) is accepted. Thus it concluded that there is no significant difference in Rate pressure product (RPP) by interval and continuous training in college level football players.

VII. LIMITATIONS

- The study consisted of a small number of Subjects.
- Study duration was small of 6 weeks & no further follow up was taken.
- Long Term Effects were not analyzed.
- The study included only 4 cardiovascular parameters.

VIII. FUTURE RECOMMENDATIONS

- Future studies should be done on larger sample size in both the groups.
- The duration of the study should be elongated for the better effectiveness of both the trainings.
- Further study can be done to determine the clinical applicability of these training regimes for different age group in football players.
- Further study can be done by comparing this regime with other training protocols to see the effect on football players.
- Further study can be done to determine the clinical applicability of these training regimes for different population.

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X. CONFLICTS OF INTEREST

The author declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

XI. REFERENCES

1. Ekblom B. Applied Physiology of soccer. Sports Med 3:50-60, 1986.
2. Kirkendall DT. The applied sport science of soccer. Phys. Sports Med 13: 53-59, 1985.
3. E.raja gopal et all influence of interval training, circuit training and combined training on selected skill related physical fitness variables and performance variables among football players ijerss volume1 issue1 jan 2014
4. Kargarfard, m. keshavarz, s. (2005), study of aerobic and anaerobic power of the iranian premier league soccer players playing in different positions. journal of harekat, tehran, 27:137-152. (persian).
5. Wisloff, u., j. helgerud and j. hoff. (1998), strength and endurance of elite soccer players. med. sci. sports exerc. 30:462–467,
6. Tumilty, d., (1993), physiological characteristics of elite soccer players. sports med. 16:80–96,.
7. Chaleh chaleh, m. (2007). study of physiological and anthropometric characteristics of soccer players in different positions: comparison iranian first soccer league with england league. master's thesis, faculty of physical education and sport sciences, university of shahid beheshti university of tehran, iran (persian).
8. Arnason, a. sigurdsson, sb. gudmundsson, a. holme, i. engebretsen, l. bahr, r. (2004). physical fitness, injuries, and team performance in soccer. med.sci. sport exerc, 36 (2), pp: 278-285.
9. Stolen, Chamari, Castagna, & Wisloff, the efficiency of interval and continous aerobic training in young soccer players.PESH 2(2013)2 95-110 2005).
10. Vucetic V. & Šentija, the difference in aerobic capacity of physically active females in relation to their age.physical education and sport vol 10. 2004
11. Singh, H. (1991). Science of Sports Training. D.V.S. Publications, New Delhi, 130, 147.
12. M. Aguiar (2008) Effects of Intermittent or Continuous Training on Speed, Jump and Repeated-Sprint Ability in Semi-Professional Soccer Players. The Open Sports Sciences Journal, 2008, 1, 15-19 15.
13. Karlman Wasserman. James E. Hansen, Darryl Y. Sue, Richard Casaburi. Brain J. Whipp- Principles of exercise testing and interpretation.1999; 3rd edition. Page 528.

14. Wisloff U, Helgerud J, Hoff J. Strength and endurance of elite soccer players. Med Sci Sports Exerc 1998; 30(3): 462-467.
15. Hickson R, Rosenkoetter M, Brown M. Strength training effects on aerobic power and short-term endurance. Med Sci Sports Exerc 1980; 12(5): 336-339.
16. Dick, F.W. (2006). Sports Training Principles. Lepus Books, London, 264.
17. Hansen, D.; Dendale, P.; Jonkers, R. A. M.; Beelen, M.; Manders, R. J. F.; Corluy, R.; Mullens, A.; Berger, J.; Meeusen, R.; van Loon, L. J. C. (2009). "Continuous low- to moderate-intensity exercise training is as effective as moderate- to high-intensity exercise training at lowering blood HbA1c in obese type 2 diabetes patients". Diabetologia 52 (9): 1798–1797.
18. Heyward, Vivian H. (2006) [1984]. "Designing Cardiorespiratory Exercise Programs". Advanced Fitness Assessment And Exercise Prescription (5th ed.). Champaign, Illinois: Human Kinetics. p. 104. ISBN 978-0-7360-5732-5. Retrieved May 7, 2012.
19. S A Ward, P Palange: Clinical exercise testing; June 2007; vol-12; page 47.
20. (Tanisho & Hirakawa, 2009; Vucetic V. & Šentija, 2004).
21. ACSM'S recourse manual for guidelines for exercise testing and prescription.2001; 4th edition. Page 372.
22. Russell R Pate, Steven N Blair, J Larry Durstine: guidelines for exercise testing and prescription- American college of sports medicine; 1991; 4th edition; page 69-70.
23. Johns Hopkins Medicine, Vital signs (body temperature, pulse rate, respiration rate, blood pressure). Baltimore, US: Johns Hopkins Health Library. Information published online, accessed 11 February 2014
24. ALMEIDA, Marcos B. and ARAUJO, Claudio Gil S.. Effects of aerobic training on heart rate. Rev Bras Med Esporte [online]. 2003, vol.9, n.2,
25. William D. Mc.Ardle, Frank L. Katch; Victor L. Katch: Exercise physiology, energy nutrition and human performance.2001; 5th edition; 321-322.
26. Reilly T & Gilbourne D (2003): Science and football: a review of applied research in the football codes. Journal of Sports Sciences 21, 693-706.
27. Stolen T, Chamari K, Castagna C & Wisloff U (2005): Physiology of soccer: An update. Sports Medicine 36(6), 501-536.
28. Bangsbo J & Michalsik L (2002): Assessment of the physiological capacity of elite players. In Spink W, Reilly T & Murphy A, editors (2002) Science and Football IV Rutledge, London 53-62.
29. Hoare DG & Warr C (2000) Talent identification& women soccer: An Australian experience. Journal of Sports Science 18, 751-758.
30. Vivian H. Heyward Human Kinetics, advance fitness assessment and exercise prescription 7th edition. 2006.
31. Kerr, Hamish(2011). "Interval Training/Fartlek". In Micheli,lyle. Encyclopedia of sports medicine, sape pp. 717-719. Retrived 14 june 2015 Atkins, William. "Interval Training". In Longe, Jacqueline. The Gale Encyclopedia of Fitness. pp. 475–477. Retrieved 14 June 2015.
32. "Rev up your workout with interval training". Mayo Clinic. Retrieved 4 June 2014.
33. Giala MJ, Gillen JB, Percival ME (2014). "Physiological and Health-related Adaptions to Low-Volume Interval training: Influences of Nutrition and sex". Sports Medicine (Auckland, NZ) 44(2): 127–137.
34. Osawa Y, Azuma K, Tavata S, et al. (2014). "Effects of 16-week high intensity interval training using upper and lower body ergometers on aerobic fitness and morphological changes in healthy men: preliminary study". Open Access journal of Sports Medicine 5: 257–265.
35. Mazurek K, Karwczyk K, Zemijeeski P, Norkoski H, Czajkowska (2014). "Effects of aerobic interval training versus continuous moderate exercise programme on aerobic and anaerobic capacity, somatic features and blood lipid profile in collegiate females". Ann Agric Environ Med 21 (4): 844–849.
36. Clemente C. J., Withers P. C., Thompson G. G. (2009). "Metabolic rate and Endurance capacity in Australia varanid lizards capacity (Squamata; Varanidae; Varanus)" Biological Journal of the Linnean Society 97 (3): 664–676.
37. Dlugosz E. M., Chappell M. A., Meek T. H., Szafrañska P., Zub K., Konarzewski M., Jones J. H., Bicudo J. E. P. W., Careau V., Garland T., Jr (2013). "Phylogenetic analysis of mammalian maximal oxygen consumption during exercise". Journal of Experimental Biology 216 (24): 4712–4721.
38. Thomas E. Hyde and Marianne S. Gengenbach, Conservative Management of Sports Injuries (2nd ed; Sudbury, Mass.: Jones & Bartlett, 2007), 845.
39. Heyward, V (1998). "Advance Fitness Assessment & Exercise Prescription, 3rd Ed". p. 48.
40. Guyton, A. & Hall, J.E. (2011). "Textbook of Medical Physiology, 12th Ed.". pp. 1035–1036.
41. NOAKESA, T.D. and MYBURGHA, K.H. and SCHALLl, R. (1990) Peak treadmill running velocity during the VO_2 max test predicts running performance. Journal of Sports Sciences, 8 (1), p. 35-45
42. Astrand, P.(1952) Experimental studies of physical working capacity in relation to sex and age. Munksgaard, Copenhagen.
43. Borg's Perceived Exertion and Pain Scales. Champaign, IL: Human Kinetics; 1998
44. Borg, G. (1970). "Perceived exertion as an indicator of somatic stress". Scandinavian journal of rehabilitation medicine 2 (2): 92–98.
45. "Target Heart Rates - AHA". Target Heart Rates. American Heart Association. 4 Apr 2014. Retrieved 21 May 2014.
46. "Tachycardia| Fast Heart Rate". Tachycardia. American Heart Association. 2 May 2013. Retrieved 21 May 2014.
47. Fuster Journal of the American College of Cardiolog 2001, pp. 78–9.
48. Schmidt-Nielsen, Knut. Animal physiology: adaptation and environment (5th ed.). Cambridge: Cambridge Univ. Press. p. 104. (1997)
49. E.raja gopal "influence of interval training, circuit training and combined training on selected skill related physical fitness variables and performance variables among football players" ijerss. 1 (1) 2014.
50. Mr.shivamurthy a "cardio respiratory endurance of football players at inter university level" jmess vol. 2 no. 2 (october, 2013)
51. Martin J Gibala "Physiological adaptations to low-volume, high-intensity interval training in health and disease" J Physiol. 2012 Mar 1; 590(Pt 5): 1077–1084.

52. Moholdt TT “Aerobic interval training versus continuous moderate exercise after coronary artery bypass surgery: a randomized study of cardiovascular effects and quality of life”. Am Heart J. 2009 Dec;158(6):1031-7.
53. Arnt Erik Tjønna“Aerobic Interval Training Versus Continuous Moderate Exercise as a Treatment for the Metabolic Syndrome” Circulation.2008,118:346-354.
54. Wisløff U “Superior cardiovascular effect of aerobic interval training versus moderate continuous training in heart failure patients: a randomized study.” Circulation. 2007 Jun 19;115(24):3086-94
55. Kirsten A. Burgomaster”Six sessions of sprint interval training increases muscle oxidative potential and cycle endurance capacity in humans” Journal of Applied Physiology.1 June 2005 Vol. 98 no. 6, 1985-1990
56. Jeffrey Warren King “A Comparison of the Effects of Interval Training vs. Continuous Training on Weight Loss and Body Composition in Obese Pre-Menopausal Women.”. Electronic Theses and Dissertations. 2001. Paper 123
57. Kuno Hottenrott,“Effects of High Intensity Training and Continuous Endurance Training on Aerobic Capacity and Body Composition in Recreationally Active Runners” Kuno Hottenrott, J Sports Sci Med. 2012 Sep; 11(3): 483–488.
58. Ragnheiður Harpa Arnardóttir“Interval training compared with continuous training in patients with COPD”june 2007 volume 101, issue 6, pages 1196-1204
59. G. Büyükyazi“Effects of continuous and interval running training on serum growth and cortisol hormones in junior male basketball players” 2005 Volume 90, Issue 1
60. Shannan e. gormley. “effect of intensity of aerobic training on v˙o2max” 2008 by the american college of sports medicine
61. K McMillan“Physiological adaptations to soccer specific endurance training in professional youth soccer players” Br J Sports Med 2005;39:273-277
62. Franco m “use of rpe-based training load in soccer” 2004. the american college of sports medicine
63. Dunbar CC, Goris C., Michielli DW, Kalinski MI: Accuracy and reproducibility of an exercise prescription based on Ratings of Perceived Exertion for treadmill and cycle ergometer exercise. Percept Mot Skills, 1994 Jun;78(3 Pt 2):1335-44
64. Dunbar C.C, R.J. Roberston, R. Baun, M.F. Blcndin, K.Mete, R> Burdett and F.L. Gloss: The validity of regulating exercise intensity by ratings of perceived exertion. Med. Sci. Sports Exec., 1992, Vol. 24, No. 1, pp. 94-99.
65. Darren E.R. Warburton“effectiveness of High-Intensity Interval Training for the Rehabilitation of Patients With Coronary Artery Disease” The American Journal of CardiologyVolume 95, Issue 9, 1 May 2005, Pages 1080–1084
66. Mikko P. Tulppo“Effects of aerobic training on heart rate dynamics in sedentary subjects” Journal of Applied Physiology. 1 July 2003 Vol. 95 no. 1, 364-372
67. Gaeini AA. Effects of aerobic continuous and interval training on rate-pressure product in patients after CABG surgery. The Journal of Sports Medicine and Physical Fitness [2015, 55(1-2):76-83
68. Darren E.R. Warburton“Effectiveness of High-Intensity Interval Training for the Rehabilitation of Patients With Coronary Artery Disease”. The American Journal of Cardiology. Volume 95, Issue 9, 1 May 2005, Pages 1080–1084.
69. Scott, Tannath J “Validity and Reliability of the Session-RPE Method for Quantifying Training in Australian Football: A Comparison of the CR10 and CR100 Scales”. Journal of Strength & Conditioning Research:January 2013 - Volume 27 - Issue 1 - p 270–276
70. Marta Elena Losa-Iglesias“Reliability and concurrent validity of a peripheral pulse oximeter and health–app system for the quantification of heart rate in healthy adults” Health Informatics Journal July 18, 2014.
71. O'Brien E, Asmar R, Beilin L, Imai Y, Mallion JM, Mancia G, et al. (2003). "European Society of Hypertension recommendations for conventional, ambulatory and home blood pressure measurement". J. Hypertens. 21 (5): 821–48.
72. Pickering et al. 2005, Recommendations for Blood Pressure Measurement in Humans and Experimental Animals Hypertension.2005, 45: p. 146
73. Baquet G, Guinhouya C, Dupont G, Nourry C & Berthoin S (2004): Effects of short-term interval training program on physical fitness in pre-pubertal children. Journal of Strength & Conditioning Research 18(4), 708-713.
74. Bangsbo J (1994): The physiology of soccer: With special reference to intense physical exercise. Acta Physiologica Scandinavica 150 (supple.619), 1-156.
75. Bradley P, Sheldon W, Wooster B, Olsen P, Boanas P & Kustup P (2009): High intensity running in English FA Premier League soccer matches. Journal of Sports Sciences, 27(2), 159-168.
76. 19. Brookes J & Knowles J (1974): A movement analysis of player’s behaviours in soccer match performance. Paper presented at British Society of Sports Psychology Conference, Salford Eng.
77. 20. Burgomaster K, Heigenhauser G and Gibala M (2006): Effect of short-term interval training on human skeletal muscle carbohydrate metabolism during exercise and time-trial performance. Journal of Applied Physiology 100, 2041-2047.
78. Timothy James Rogers. the effect of high intensity running training on work capacity in football (soccer). School of Exercise Science Faculty of Health Sciences Australian Catholic University September 2010.
79. Fox E, Bartels R, Billings C, Mathews D, Bason R & Webb W (1973): Intensity and distance of interval training programs and changes in aerobic power. Medicine & Science in Sport & Exercise 5(3), 15-22.
80. Laursen P & Jenkins D (2002): The scientific basis for high-intensity interval training. Optimising training programmes and maximising performance in highly trained endurance athletes. Sports Medicine 32(1)53-73.
81. Thevenet D, Tardieu-Berger M, Barthoin S & Prioux J (2007): Influence of recovery mode (passive vs. active on time spent at maximal oxygen uptake during an intermittent session in young and endurance trained athletes. European Journal of Applied Physiology 99(2), 133-142.
82. David W. HilEffect of training on the rating of perceived exertion at the ventilatory threshold. European Journal of Applied Physiology and Occupational Physiology.March 1987, Volume 56, Issue 2, pp 206-211.
83. Marcos B. Almeida.Effects of aerobic training on heart rate. Rev Bras Med Esporte vol.9 no.2 Niterói Mar./Apr. 2003