Effect of Interval and Continuous Training on the Athlete's Aerobic Fitness level

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ABSTRACT

The purpose of this study was to compare the effect of continuous and interval training on athlete's aerobic fitness level. To meet this objective experimental research design was used. For this study 30 middle and long distance athletes were selected as a subject. All these athletes were divided into two different groups (continuous group (CG) and interval group (EG)) based on their pretest results. To see the effect of these training methods and to analyze whether there is a significant different between athlete's aerobic fitness level after 12 weeks intervention, paired and independent sample t- test with an alpha value of .05 was employed. Furthermore, to examine the magnitude of observed differences between groups, effect sizes (Cohen's d) were calculated. Finally, Results in this study showed that interval training group showed significant improvements in aerobic fitness level better than continuous training group. I.e. , in Astrand treadmill test the mean VO2max score of interval group was 76.81 ± 1.87 and 68.44 ± 3.14 for continuous group with P = .032 ; in 2.4 Km run test the mean time for interval group was 0:07:21 ± 0:00:27 and 0:08:05 ± 0:01:00 for continuous group with P = .017 ; in 20m beep incremental test the mean result for interval group was 17.74 ± .38 and 15.93 ± 2.93 for continuous group , P = .045. Then, it was concluded that interval training method was beneficial in improving athlete's aerobic fitness level than continuous training method.

1. INTRODUCTION

1.1. Back Ground of the Study

Success in sports can be determined by a large number of interrelated factors. Among these training is the most decisive factor which directly influences the improvement of an athlete's performance. Sport training is a pedagogical process based on scientific principles aiming at preparing sportsmen for higher performances in sports competitions (Hardial, (1991) [1].

The magnitude of the training response lies on different factors like, the duration of the exercise bouts, the intensity and the frequency with which exercises are performed, the initial training status of athletes, genetic potential, age and gender of the individual (Wenger & Bell, (1986)) [2].

Therefore, specifying an optimal training regimen for athlete's fitness improvement requires knowledge of applying different training methods Helgerud, Hoydal, Wang, Karlsen, Berg, & Bjerkaas, (2007) [3].

The purpose of any training program is to optimize the athlete's performance. In athletics, there are different fitness qualities in which athletes should develop through scientific training. Among this, aerobic fitness is an important fitness quality for exercises which require oxygen for energy production.

Ben (2005) [4] states that aerobic fitness is the measure of how much oxygen your body can use during maximal exertion. Changes in aerobic fitness highly depend on how much oxygen - carrying blood your heart pumps to the working muscle with every beat and the ability of the muscle to use oxygen for energy production. Thus, the more oxygen your body can process, the more energy you can produce and the greater your aerobic fitness (Joe, (2016)) [5].

Athletes with a higher aerobic fitness can exercise high volume activities with less fatigue and can recover quickly from repeated work than athletes who have less aerobic fitness (Bompa, & Haff, (2009)) [6].

In fact, an athlete's aerobic fitness is highly affected by factors like efficiencies of cardio respiratory and cardiovascular systems it has been observed that the magnitude of physiological differences between athlete's aerobic fitness highly lies on the training methods they employed during training sessions (Casamichana, Castellano, & Dellal, (2013)) [7].

Even though both high volume low intensity continues and low volume high intensity interval trainings are recommended to develop athlete's aerobic fitness (Bompa, & Haff (2009) [6]; Gibala & McGee (2008) [8]; MacPherson, Hazoll, Oliver, Petrson, & Lemon, (2011) [9]) most of traditional programs are focus on continuous training methods containing high volume and low intensity training [10].

Research results in the field states that this type of training is important to improve cardiac functions such as increased cardiac output through an increased in stroke volume, maximum oxygen uptake, capillary network, mitochondrial enzymes, energy producing system enzymes and finally increase aerobic fitness of individuals [11].

Despite most training programs focus on continuous training method, recent study results revealed that interval training method with active recovery is a better training modality for the improvement of athlete's aerobic fitness than continuous training method (Thompson (2005) [12]; Billat, (2001) [13]; Kubukeli, Noake, & Dnnis, (2002) [14]; Daussin, Zoll, Dufour, Ponsot, Lonsdorfer, & Doutreleau (2008) [15]). Laursen and Jenkins in their study also confirm that interval training where periods of hard exercise (work intervals) interspersed with periods of rest or lighter work (rest intervals) improves athlete's

aerobic fitness than continuous training method (Laursen & Jenkins, 2002) [16].

Although both training methods have been shown to improve aerobic fitness of athletes, it is still not clear yet either continuous or interval training can better improve aerobic fitness. Thus, the purpose of this study was to compare the effect of these two different training methods on the athlete's aerobic fitness level.

1.2 . Hypothesis of the study

To develop a specific direction and better understanding about this study and to insure the entire study process remains scientific and reliable the following hypothesis was formulated.

HA: Interval training method will significantly improve an athlete's aerobic fitness level than continuous training method.

1.3. Delimitations of the Study

To make the research manageable, the study population was delimited to 30 Birihan athletics project middle and long - distance athletes. The reason for selecting these athletes is because of the aerobic nature of the training intervention which was delivered during the study and the nature of the independent variable (aerobic fitness) which were measured is directly associated with long and middle distance running performance than other events.

Beside, to give better conclusions about these training methods effect on the athlete's aerobic fitness level the designed training intervention programs was delimited for 12 weeks period.

Since investigating all the various possible effects of two training methods (continuous and interval training) on the athlete's performance is beyond the span of a single study the scope of the study was delimited to evaluate these training methods effect on athlete's aerobic fitness level only.

2. MATERIALS AND METHODS

2.1. Research Design

Because of its pre- posttest nature of the study experimental research design was used. While the Interval training and continuous training method were the independent variables and athlete's aerobic fitness level is the dependent variable.

2.2. Training Protocol

Each study group has been equal training period that was lasted for 12 weeks, in which all participants exercise 3 days per week with one day rest in between. And also, the training program was planned to be progressive, so that both groups utilize their training starting at 40% of their competition pace progressing to approximately 90% of their competition pace. Furthermore, Due to potentially confounding results, subjects who undertake in additional training outside of this study was forced to stop their training.

2.3. Sources of Data and Data Collection Instrument

For this study primary sources of data were athlete's tests results. As data collection instrument the researcher applied a set of tests (Astrand Treadmill Test, The 2.4 km Run Test, and 20m beep incremental test) before and after the training intervention period.

2.4. Data Analysis Technique

Since, it helps the researcher to measure, evaluate, and analyze the effect of continuous and interval training method on athlete's aerobic fitness quantitative methods of data analysis was used

All statistical analysis was calculated by using the Statistical Package for the Social Sciences (SPSS), version 20. Statistical significance was accepted at an alpha level less than or equal to 0.05. To note whether there was differences in athlete's aerobic fitness level in response to these training methods an independent sample t-test was employed. In addition, to examine the pre - post training effect of each training methods paired t-test was employed.

Furthermore, to assist in understanding the magnitude of observed differences between groups, effect sizes were also calculated for testing results.

3. RESULTS

3.1. Paired t Test Results of Aerobic Fitness Tests

Table 3.1. Paired T Test Results of Aerobic Fitness Test

Tests	Groups	Mean		St .deviation		Paired differences			
		Pre Test	Post test	Pre Test	Post test	Mean	St.deviation	T	Sig. (2-tailed
VO2 max test	CG	65.18	68.44	3.62	3.14	3.25	2.016	-6.25	.000
	IG	67.92	76.81	2.37	1.87	-8.89	4.79	-7.19	.000
2.4 km test	CG	0:08:15	0:08:05	0:01:04	0:01:00	0:00:10	0:00:16	2.43	.029
	IG	0:08:15	0:07:21	0:00:04	0:00:27	0:00:54	0:01:14	2.84	.013
20m beep test	CG	15.08	15.93	3.10	2.93	-.85	.68	-4.82	.000
	IG	14.25	17.74	.69	.38	-3.48	1.67	-8.09	.000

A paired sample t test results in the above table revealed that after 12 week training intervention program continuous training group post test results (M = 68.44, SD = 3.14) were significantly (P = .000) greater than their pretest results (M = 65.18, SD = 3.62) with. In addition, interval training group VO2max posttest results (M = 76.81, SD = 1.87) was significantly (P = .000) greater than their pretest result (M = 67.92, SD = 2.37).

In addition a paired sample t test results for 2.4 km trial test in the above table shows that continuous training group post test results (M = 0:08:05, SD = 0:01:00) were significantly (P= .029) greater than their pretest results (M = 0:08:15, SD= 0:01:04).

And also, interval training group posttest results (M = 0:07:21, SD = 0:00:27) was significantly (P = .013) greater than their pretest result (M= 0:08:15, SD = 0:00:04).

Furthermore, to examine the effect of continuous and interval training methods on 20 m beep aerobic fitness test, paired sample t test was conducted and results in the above table shows that both group was found to be significant (p = .000) in pre and post test results (i.e., continuous training group pretest M = 15.08, SD= 3.10 and posttest M= 15.93, SD = 2.93; interval training group pretest M = 14.25, SD .69 and posttest M = 17.74, SD .38).

3.2. Independent T Test Results of Aerobic Fitness Tests

Table 3.2. Independent t test results of aerobic fitness tests

Test		Levine's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Mean Diff.	Std. error Diff	95% CI of the diff. lower	95% CI of the diff. Upper	Sig. 2 tailed
Vo2 max	EVA	8.73	.006	-2.29	28	-8.37	3.66	-15.87	-.88	.030
	EVNA			-2.29	22.8	-8.37	3.66	-15.94	-.81	.032
2.4 km	EVA	11.88	.000	2.61	28	0:00:44	0:00:17	0:00:09	0:01:19	.014
	EVNA			2.61	19.75	0:00:44	0:00:17	0:00:08	0:01:20	.017
20m beep	EVA	13.57	.001	-2.13	28	-1.81	.85	-3.54	-.07	.042
	EVNA			-2.13	20.73	-1.81	.85	-3.57	-.04	.045

An independent sample t-test results in the above tables revealed that athletes who participated in interval training method score better Vo2 max results than athletes who participated in the continuous training group. In addition, as it was assessed by Leven's test for equality of variances homogeneity of variances was violated (p = .006), so equal variance not assumed were used and t (22.8) = -2.29, p = 0.032 two -tailed, Mean

Diff = -8.37, SE diff = 3.66, and the 95% CI is (-15.94, -.80) which doesn't contain 0 this agree with P - value of the significance test. Thus, it is possible to say that there was a significance difference between interval and continuous training groups with moderate effect size (Cohen's d = 0.83).

Results of this study are consistent with another study done by Helgerud et al. (2007) [3] which examine responses in maximal oxygen uptake (VO2max). In their study subjects were randomly assigned to one of four groups (long slow distance (70% maximal heart rate; HR max), lactate threshold (85% HR max); 15/15 interval running (15 s of running at 90–95% HR max followed by 15 s of active resting at 70% HR max), and 4 - 4 min of interval running (4 min of running at 90–95% HR max followed by 3 min of active resting at 70% HR max)). Finally, Results of the study shows that aerobic interval training methods interspersed with active recovery activity resulted in significantly increased VO2max compared with long slow distance and lactate-threshold training intensities (P = 0.01).

Therefore, increment in VO2max induces aerobic fitness adaptations through increased capacity for whole-body and skeletal muscle lipid oxidation enhanced peripheral vascular structure and function, and improved exercise performance (Gibala & McGee, 2008) [8].

Even though, some study results show that these two training methods will produce similar improvements in VO2max. Eddy et al. (1977) [17] conduct a study on subjects participating in a training program upon bicycle ergo meter for 7 weeks with training 4 days a week. The CG trained at 70% VO2max and the IG trained at 100% VO2max for 1 - minute and 1 - minute rest. Finally, CG and IG training produced identical changes in VO2max.

In line with this study, Gulbin (2014) [18] also confirms that both training methods have similar effect on VO2max of individuals. In this study, 15 subjects were divided into two groups (short sprint interval and continuous) according to their initial VO2max levels. The SIT program consisted of 4-6 Wingate anaerobic sprints with a 4.5 min recovery, while CET consisted of 30-50 min cycling at 60% VO2max. Results in this study showed similar results from SIT and traditional CET.

Such results may due to inappropriate duration, intensity and recovery of the intervention activity given (i.e. the workload may not identical for the two groups) and not considering the energy expenditure of these two training methods. Also,

some of these studies were conducted on non-athletes which may produce significant result with minimal training stimulus for a short period time.

Furthermore in these studies, the only way to determine wither a subject was working exactly at a given intensity of their VO2max was through the pace of the training which may not assure to work at expected load. Thus, the results of this study are not convincible.

Beside, in this study the average time taken to finish 2.4 Km between two groups was compare through independent sample t - test. As it was assessed by Leven's test for equality of variances (p= .001) homogeneity of variances was violated, so equal variance not assumed were used; t (19.75) = 2.61, p = .017 two - tailed, Mean Diff = 0:00:44, SE diff = 0:00:17, and the 95% CI is (0:00:08, 0:01:20) which doesn't contain 0; this result doesn't violet P - value of the significance test. Therefore, in the average time taken to finish 2.4 km interval training group scores significantly better than continuous training group ($P < .05$) with moderate effect size (Cohen's d = 1.0679).

Consistent results also noted in Dahle (2016) [19] study which was conducted on 27 subjects which were randomly assigned to 3 groups: a high - frequency group that performed HIIT/SIT 3x week consisted of 4 x 3 min intervals at 90-100% of velocity at maximal oxygen consumption (vVO2 max) with 4 min of active recovery between, a low - frequency group that performed HIIT/SIT 2x week, and a continuous training group (CG) that performed moderate - intensity training 3x week. Then 1.5 mile run performance was measured and retested after 10 weeks. At the end of 6 weeks, all groups significantly improved in mean 1.5 miles run time ($p<0.05$). Finally in his study, it is observed that interval training with active recovery activities produce better improvement in 1.5mile runtime.

Alternatively, Billat et al. (1999) [20] found non-significant changes in 3000-m running performance after a 4-week interval training program. This result in this study suggests that the improvements in running performance were not significantly improved through interval training than continuous training methods.

Despite, the training intervention period in this study was not sufficient to observe a significant change in the measured fitness elements. And also in this study great concern was on a load of work intervals and less emphasis was given for the load and type of the recovery activities which directly associates with the metabolic systems of our body. And also, the training load which was delivered during the intervention period which affects the efficiency of both new interval and continuous training methods was not clearly stated.

Silva et al., (2017) [21] confirms that an improvement in the better running economy leads to a lower energy cost during sub -maximal running bouts, which allows the athletes to finish a given distance with the least time. So, interval training programs with active recovery activity are very important to compensate for a reduction in the energy cost of running. Thus, an interval training method with brief active recovery is an effective training method to induce running economy and as a result aerobic fitness than continuous training methods.

Furthermore, to compare an athlete's aerobic fitness through beep incremental aerobic fitness test, an independent sample t - test was conducted. And as it was assessed by Leven's Test for equality of variances (p = .001) homogeneity of variances was violated, so equal variance not assumed were used; t (20.73) = -2.13, p = .045 two -tailed; Mean Diff = -1.81, SE diff = .85, and the 95% CI is (-3.57, -.04) which doesn't contain 0 and doesn't violet P- value of the significance test. The effect size for this analysis was found Cohen's convention for a moderate effect (d=.78). Even though both training methods produce improvements in this aerobic fitness test, interval training method shows significant improvement better than continuous training method.

On the other hand, the results of this study negate with Acevedo & Goldfarb (1989) [22] study. According to the result of their study, lactate and ventilatory threshold which help athletes to tolerate intensity increments during exercise didn't show significant difference between interval training and continuous training methods after training interventions. In line with this study, Jeff, Robert, & Michael (1994) [23] conducted a study and results show, after 7-week training intervention subjects who train with high - intensity interval training and continuous training produce similar changes in lactate threshold.

Even though results show that there is no significant difference between interval and continuous training methods on incremental exercise, it was noted that the given training load during intervention period which may produce such aerobic fitness results was not clearly measured.

4. CONCLUSIONS

Based on the major findings of the study the following points are stated as conclusions.

Both interval and continuous training methods were effective in improving athlete's aerobic fitness. However, it was examined that interval training with active recovery between work intervals significantly improves an athlete's aerobic fitness better than continuous training method.

In this study it is also observed that interval training method was time efficient training modality.

To some extent reasonably high volumes of continuous training can be considered as an important precondition for tolerating and responding well to a substantial increase in training intensity and effective in stimulating some physiological adaptations. So, this type of training method should not be viewed as wasted training session by coaches and athletes.

5. RECOMMENDATIONS

In light of major findings and conclusions of this study the following recommendations are forwarded.

Since new interval training methods have more advantages than continuous training method to improve an athlete's aerobic fitness, athletes are advised to use this training method based on the principles of training.

When designing training sessions using interval training method, coaches and athletes should consider the intensity and duration of the recovery activities based on the intensity of work intervals.

While doing interval training, it is important to make recoveries more dynamic and the whole session should be more rhythmic and dictated by the perception of pace, rather than depending on a stopwatch.

For the efficiency of result and conclusions, it is recommended that researchers who conduct their study on the comparative effect of interval and continuous training need to make sure that the training work - load given for both training methods is identical.

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