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A Comparative Study of Effect of High Intensity Interval Training and Slow Continuous Training on the Aerobic performance in Adult Healthy Untrained Male Volunteers

(Original Article)

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Abstract:

Introduction: *Endurance is a key requirement for overall physical fitness and most other organised sports. Coaches have different favourite methods to train for endurance, and jury is divided on which is the best of them.*

Aim: *This study aims to compare the effects of two popular methods of endurance training, High Intensity Interval Training and Slow Continuous Training.*

Hypothesis: *High Intensity Interval Training provides better gain in endurance than Slow Continuous Training in untrained adult male over a six week training protocol.*

Methods: *During the period 2010 – 2013, 238 young adult healthy male volunteers were randomly divided into HIIT and SCT groups. Both groups were provided supervised training as per protocol given below. Each session additionally incorporated warm up and cool down.*

HIIT: *03 sessions/ week for 06 weeks at velocity equal to maximum velocity achieved in pre experiment beep test, with Training/Active rest in ratio of 1:1 (30s/30s), 05 reps per set, 04 sets per session with 03 min rest between sets*

SCT: *05 sessions of 30 min each per week for 06 weeks, at velocity equal to 60 – 70% of maximum velocity achieved in pre experiment beep test*

Endurance using beep test was measured just before administering the experimental protocols, at 3 weeks interval and upon conclusion of study at 6 weeks. VO2max was calculated using VO2max calculator provided at the official website http://www.thebeeptest.com/calculator.htm. The results were compared for statistical significance.

Results: *Mean pre test VO2max levels of both HIIT and SCT were comparable (34.29mL/kg vs 37.12mL/kg). After three weeks of training, HIIT group showed higher enhancement in VO2max (13.87% vs 8.76%) than SCT group. After six weeks of training, HIIT group continued to have higher gain in VO2max (20.75% vs 15.19%) than SCT group. The study shows that High Intensity Interval Training provides superior gain in endurance than Slow Continuous Training.*

Conclusion: *High Intensity Interval Training provides superior gain in aerobic capacity than Slow Continuous Training over 6 weeks of training using lesser training time.*

Keywords: *High Intensity Interval Training, Slow Continous Training, Endurance, HIIT, SCT,Aerobic Performance, VO2max*

Introduction

Increasing awareness about sports, increasing level of competition, packed calendar and paucity of time place greater emphasis on coaching methodology. Today, athletes are challenging limits of human imagination. The focus of coaching is shifting towards more effective ways of achieving the goal. **Dag Kaas**, who has trained 12 world champions in four different sports, opines that *"to become a world champion in endurance disciplines, you have to train SMART, AND you have to train a LOT. One without the other is insufficient."*

Two of the most commonly training methods used by coaches and athletes the world over are 'High Intensity Interval Training' and 'Slow Continuous Training'. Most endurance athletes use high intensity training methods to train for competitions (**Paton and Hopkins, 2004**)[1]. While the effect of low to moderate intensity training on aerobic fitness are well documented, the relative impact of short, high intensity training versus slow, long distance training has been debated for decades among athletes, coaches, sports scientists and team physians (**Seiler and Tonnessen, 2009**)[2]. **Astrand and Rodahl**[3](1986), in the textbook of work physiology, wrote- *"it is an important but unsolved question which type of training is most effective: to maintain a level representing 90 % of the maximal oxygen uptake for 40 min, or to tax 100 % of the oxygen uptake capacity for about 16 min".* In absence of well defined scientific inputs, athletes and coaches juggle with both methods based on their experience, imagination and beliefs. This may prevent the athlete from attaining performance level commensurate with his/her genetic potential.

The economic angle of the issue also needs mention. Good quality training frequently comes at a cost, and almost all athletes must find time within the frame of their employability. Professional and family requirements place a great demand on the time available to train. The optimal utilization of time is a must in order to achieve best possible result.

Further to the sportsmanship angle is the point of view from the common man who wishes to use sports to maintain health. Here again, time is a great constraint, as is the level of motivation. A time effective method of training which provides equal or better result as compared to the traditional training methods is more likely to find acceptance among a population that is only beginning to comprehend the ill effects of sedentary life – style and yet is unable to find time or motivation – frequently both – to exercise regularly.

The topic has justifiably caught the attention on sports scientists in the recent past, and a number of studies have been conducted in the past two decades. These studies have mainly focused on few elite athletes or a cohort which is already showing manifestations of one or more life style disease. The number of subjects has been necessarily small. Based on some of these studies, the pendulum is swinging in favour of high intensity interval training. But there are lots of dissenting voices. The criticism revolves mainly around small sample size.

Materials and Methods

Aim: This study aims to compare the effects of two popular methods of endurance training - High Intensity Interval Training (HIIT) and Slow Continuous Training (SCT) on the Areobic performance of healthy, untrained male individuals.

Hypothesis: High Intensity Interval Training provides better gain in endurance than Slow Continuous Training in untrained adult male over a six week training protocol.

During the period 2010 – 2013, 238 young adult healthy male volunteers were randomly divided into HIIT and SCT groups. Both groups were provided supervised training as per protocol given below. Each session additionally incorporated warm up and cool down.

HIIT: 03 sessions/ week for 06 weeks at velocity equal to maximum velocity achieved in pre experiment beep test, with Training/Active rest in

ratio of 1:1 (30s/30s), 05 reps per set, 04 sets per session with 03 min rest between sets

SCT: 05 sessions of 30 min each per week for 06 weeks, at velocity equal to 60 – 70% of maximum velocity achieved in pre experiment beep test

Endurance using beep test was measured just before administering the experimental protocols (pre-experimental testing), at 3 weeks interval (experimental testing) and upon conclusion of study(post-experimental) at 6 weeks. VO_{2max} was calculated using VO_{2max} calculator provided at the official site http://www.thebeeptest.com/calculator.htm. The results were compared for statistical significance.

The Inclusion Criteria were: 1.Male 2.Age > 18 yrs, < 30 yrs 3.BMI > 16, < 30 4.Recreationally active 5.Absence of any health related complication in past 01 yrs 5.Absence of any disease as elicited by history and routine medical examination 6.No h/o of competitive sports participation at State level or above. And, the criteria to exclude were: 1.Physical Deformity 2.Diagnosed or suspected lifestyle disease 3.known musculoskeletal or cardiorespiratory disease 4.Competitive sports participation at State level or above / professional training for the same.

All subjects were instructed to continue normal daily activities and to refrain from beginning any other training until completion of the study.

The entire study was carried out at Guru Nanak Dev University, Amritsar, and nodal centers of Sports Medicine Centre, Roorkee.

A written consent was obtained from all the volunteers.

Results

The pre test parameters were comparable in both the groups in terms of Age, Height and Weight (Table 1).

Mean pre test VO_{2max} levels (pre-experimental) of both HIIT and SCT were comparable (34.29mL/kg vs 37.12mL/kg). After three weeks of training (experimental), HIIT group showed higher enhancement in VO_{2max} (13.87% vs 8.76%) than SCT group. After six weeks of training (post-experimental), HIIT group continued to have a higher gain in VO_{2max} (20.75% vs 15.19%) than SCT group (Table 2).

When the mean pre-experimental and post experimental VO_{2max} levels were evaluated in the HIIT group, it showed a statistically significant increase (34.4 to 41.4 ml/min/kg, p-value<0.05){Table 3}. Similarly, an enhancement in the VO2max levels (37.1 to 42.7 ml/min/kg) was also observed in the SCT group with a significant p-value(less than 0.05) {Table 4}.

At the end of the training schedules, the HIIT group showed greater increase in the absolute VO2max levels as compared to the SCT group , that were 7.0 and 5.6 respectively, with a highly significant p-value of 0.013(Table 5).

Table 1: Pre- test parameters

	HIIT	SCT
Age (yrs)	20.25 ± 3.0	20.45 ± 3.10
Height (m)	1.78 ± 0.067	1.71 ± 0.043
Weight (kg)	67.08 ± 6.968	65.86 ± 5.13

Table 2: Increase in VO2max in both the groups

VO_{2max} (mL/min/kg)	**Baseline**	**03 weeks**	**Increase**	**06 weeks**	**Increase**
HIIT	34.29 ± 0.47	39.04 ± 3.26	4.75 (13.87%)	41.40 ± 3.67	7.11 (20.75%)
SCT	37.12 ± 6.15	40.38 ± 4.79	3.26 (8.76%)	42.76 ± 4.62	5.64 (15.19%)

Table 3: Comparision of Mean VO2max in HIIT group (n=119)

HIIT	**Mean VO_{2max} (mL/min/kg)**	**STD DEVIATION**	**STD ERROR**	**p-value**
AT 6 WEEKS	41.4	3.68	.33	<0.05
AT BASELINE	34.4	3.42	.31	

Table 4: Comparision of mean VO2max in SCT group(n=119)

SCT	Mean VO_{2max} (mL/min/kg)	STD DEVIATION	STD ERROR	p- value
AT 6 WEEKS	42.7	4.61	.42	<0.05
AT BASELINE	37.1	6.14	.56	

Table 5: Comparision in the increase of VO2max in both groups

Group	Mean change in VO_{2max}	Std Error	p value
HIIT (n=119)	7.0	0.35	**0.013**
SCT (n=119)	5.6	0.41	

Table 6: Related articles on various study groups

Authors	Year	n	Ref Population	Intervention	Parameters studied	Key Findings
Helgerud et al	2007	40	healthy, nonsmoking, moderately trained male subjects	8 weeks	maximal oxygen uptake (VO2max), stroke volume of the heart (SV), blood volume, lactate threshold (LT), and running economy (CR)	High-intensity aerobic interval training resulted in significantly increased VO2max compared with long slow distance (p<0.01)
Driller MW et al	2009	10 (M-5, F-5)	well-trained rowers	4 weeks	2000-m time, 2000-m power, relative Vo2peak	HIT produced greater improvements in relative Vo2peak (7.0 +/- 6.4%) than CT.
Tanisho K & Hirakawa K	2009	18	lacrosse players.	15 weeks	Maximal anaerobic power, maximal oxygen uptake (V(O2max)), and intermittent power output	Maximal anaerobic power significantly increased in IT (p </= 0.05), whereas V(O2max) increased in both training groups (p </= 0.05).
Nybo L et al	2010	36	untrained men	12 weeks	VO2max, blood glucose concentration 2 h after oral ingestion of 75 g of glucose	superior improvement in cardiorespiratory fitness INT (14% +/- 2% increase in V˙O2max) compared with strength training, non training (7% +/- 2% and 3% +/- 2% increases)
Sperlich B et al	2010	26	in 9-11-year-old competitive swimmers	5 weeks	100 and 2,000 m time (T(100 m) and T(2,000 m)), VO(2peak) and rate of maximal lactate accumulation (Lac(max))	VO(2peak) increased following both interventions (P < 0.05; effect sizes = 0.46-0.57). The increases in VO(2peak) following HIIT was achieved in significantly less training time (~2 h/week).
Astorino TA et al	2011	20 (M-11, F-9)	Active young men and women	6 session (2-3 weeks)	VO(2max), pulse, peak/mean power output, fatiguability, substrate oxidation, and voluntary force production of the knee flexors and extensors	magnitude of change in VO(2max) (5.9 vs. 6.8%), power output (10.4-14.9% vs. 9.1-10.9%), and substrate oxidation was similar (p > 0.05) between men and women
Sperlich B et al	2011	19	14-yr old soccer players	5 weeks	VO_2max, 1000-m time, sprinting & jumping performance	VO_2max increased significantly (7.0%) from pre to post in HIIT
Gosselin LE et al	2014	8	young physically active subjects	3 weeks	VO2max, BP, HR, RPE, and blood lactate, total caloric energy expenditure	HIT performed at ~90% of VO2max is no more physiologically taxing than steady state exercise conducted at 70% VO2max

Discussion

There have been numerous studies on various group and type of subjects in the past, of which I consider the following few studies to be mentioned here in this article(Table 6). Helgerud et al(2007) conducted study on moderately trained subjects(n=40) and obtained a significant enhancement of VO2max levels in the HIIT group as compared to the long slow distance[4]. Driller MW et al(2009) studied well trained Rowers(n=10) over 4 weeks and showed greater improvement in the relative VO2 peak by HIIT than CT[5]. Lacrosse players (n=18) were studied by Tanisho K and Hirakawa K(2009) , who highlighted the significant improvement in the anaerobic power in the HIIT group as well, in addition to the aerobic power (in terms of VO2max) which increased in both the training groups[6]. Nybo L et al(2010) studied 36 untrained men over 12 weeks to attain a superior improvement in cardiovascular fitness showing greater enhancement in the VO2max levels[7]. Sperlich B et al (2010) studied 9-11 year old competitive swimmers to conclude that the increase in VO2max following HIIT was achieved in significantly less training time (approx. 2h/week)[8]. They also studied 14 yr old soccer players(2011) and observed a significant increase in VO2max of 7% from pre to post HIIT[9]. Astorino TA et al (2011) put forth that the magnitude of change in VO2max, power output and substrate oxidation was similar in both men and women with no statistically significant difference[10]. Gosselin LEet al(2014) stated that HIIT performed at vo2max>90% was no more physiologically taxing than steady state exercises conducted at Vo2max of 70%[11].

Little JP et al (2010) tried to demonstrate potential mechanisms of low-volume high-intensity interval training induced mitochondrial biogenesis in human skeletal muscle. They opined that a practical model wherein low volume HIT was potent stimulus for increasing skeletal muscle mitochondrial capacity and improving exercise performance. Their results also suggested that increases in SIRT1, nuclear PGC-1alpha, and Tfam may be involved in coordinating mitochondrial adaptations in response to HIT in human skeletal muscle[12].

These all studies were conducted on a relatively smaller sample size, however, Our study has involved by far the maximum number of volunteers as could be found to be mentioned in the literature.

Conclusion

Our study has led us to conclude as follows- 1.Both HIIT and SCT produce significant increase in endurance over 6 weeks of training. 2.Enhancement in VO2max over 06 weeks of training is significantly higher in HIIT as compared to SCT.3.Increase in VO2max is achieved with less training time using HIIT (30 min/week) as compared to SCT (150 min/week)

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