The effect six-week intense interval training and moderate aerobic continuous training on the Peak power output (PPO) and Mean power output (MPO) sedentary males

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Abstract

The aim of present study was to the effect six-week intense interval training and moderate aerobic continuous training on the Peak power output (PPO) and Mean power output (MPO) sedentary males.

In present study, 28 sedentary male subjects (20 to 30 years old) from university of Tabriz tended to participate. Two types of training (interval Vs. Continuous) for 4 weeks including 4 sessions a week and 45-minute duration for each session were considered as an independent variable (Interval training: 10-minute warm up, 6-9 repetition of 30-second dash-run, and Continuous training: 10-minute warm up, 30-minute running with 70%-75% reserved heart rate and 5-minute cooling down). Prior to administering independent variable, all subjects went through preparatory phase including 30-minute low intensity aerobic training (3 sessions a week). Hence, all homogenous subjects were randomly assigned to two types of training. Indices of Peak power output (PPO) and Mean power output (MPO) were measured. Having collected results, in order to observe the normality of data and effect of independent variable on dependent variables, Kolmogorov-Simonov test and repeated measure analysis of variance, independent T test at the significance level of 0.05 were used respectively.

Results: the results of present study indicate that both types of training give rise to MPO and PPO (p˂0.05). There was significant Anaerobic mean power and were similar between two groups, on the other hand, anaerobic peak power were significantly different between two groups (P˂0.05).

Conclusion: Considering results of present study, anaerobic interval training may be more efficient than continuous aerobic training.

Key words: Peak power output (PPO), Mean power output (MPO), intensive interval training, moderate aerobic continuous training, sedentary males

Introduction

High intensity interval training has a number of benefits including improved aerobic and anaerobic energy production, improved oxygen transport, enhanced lactate clearance, increased lactate threshold, improved speed/power output, enhanced neuromuscular co-ordination/exercise efficiency and may lead to improvements in the VO₂max. HIIT is highly beneficial to fitness enthusiasts, where it allows individuals to maximize cardiovascular fitness and calorie consumption in a minimal time period, and
endurance athletes, where it can bring about additional improvements in aerobic and anaerobic metabolism beyond those brought about through basic aerobic fitness training (Thomas, 2012). There is growing research supporting the benefits of intense anaerobic intervals on endurance exercise performance. King et al. (2009) found that the inclusion of 12 x 30 second work bouts at 175% PPO (the peak power sustained in a max test) led to a substantial enhancement of performance with improved 40-km time trial cycling performance. The researchers speculated that this improvement may have been due to improved buffering capacity that would allow a greater amount of work to be performed. The benefits of supra-maximal sprint training on cycling performance were confirmed in a later study where the same sprint HIIT session (12 x 30 seconds at 175% PPO with 4.5 minute recoveries) led to a significant improvement in PPO and 40 km time trial performance in a group of highly trained cyclists (Jackson et al., 2012).

The amount of high intensity interval training sessions that can be undertaken is limited due to an increased risk of overtraining. This is due to increases in stress hormones following excessive use of high intensity training. When researchers looked at the effects of increasing the number of weekly HIIT sessions on exercise performance and stress hormone levels, they found that increasing HIIT sessions to 3x per week did not improve performance and led to increased levels of norepinephrine (a stress hormone), indicating an increased risk of overtraining (Murias et al., 2015). For a long time, the physical examination of athletes mainly consisted in the study of cardiovascular performances and endurance. Interest in optimizing the magnitude of adaptation resulting from physical training, while minimizing the time and effort devoted to training, is a topic of considerable interest within the exercise community. Including classical studies of interval training for athletic performance (Astrand et al., 1960; Muller, 1953) the substantial body of evidence regarding the effects and side effects of variations in the Frequency, Intensity, Time and Type (FITT) of training are effectively codified in ACSM’s Guidelines for Exercise Testing and Prescription (Pescatello et al., 2013). Studies show that the performance of endurance athletes, according to the type of training in addition to factors such as efficiency, peak aerobic power of the motor, Neuromuscular adaptations, anaerobic power, the adaptability of the endocrine system, and the ability to delay affected lactate threshold (Pescatello et al., 2013).

The pertinence of the assessment of these aerobic tests was highly debatable for the athletes who were specialised in power events (sprint, jumping, throwing, etc.) and performed short “supramaximal” exercises, that is, exercises whose power output was higher than the maximal aerobic power. Physical examination could not be restricted to aerobic testing but had to include the assessment of anaerobic performance. Moreover, it became obvious that the assessment of mechanical factors determining athletic performances (strength, speed, and maximal mechanical power) should be added to the usual tests mainly focused on bioenergetics. Maximal mechanical power was estimated from the results of vertical jump tests and staircase tests derived from the tests previously proposed (Sargent, 1981; Davies, 1971). The laboratory involved in physical examination generally possessed a friction-braked cycle ergometer and several tests of maximal anaerobic power on a cycle ergometer were proposed (Bar-Or, 1978; Crielaard, 1981). The differences between these protocols of all-out cycling exercise mainly concerned the value of the load (i.e. the braking force) or the duration of exercise.

In compliance with the WHO recommendations, the physical activity level for maintaining a good health condition should include at least 150 minutes of aerobic exercises with moderate intensity per week, or at least 75 minutes of intensive aerobic exercises, or an equivalent total volume of moderate and intensive physical activity. Additional health benefits can be expected when physical activity is increased above 300 minutes per week. Furthermore, health benefits can be gained when additionally stretching and resistance exercises performed twice a week are included (Löllgen, 2009). Many studies have confirmed the profitable effects of physical activity on indices of health, including: decreasing BMI, reducing fat tissue, increasing lean body mass, decreasing resting heart rate and profitable modification of lipid profile (WHO., 2010; Donnelly, 2009; Hoffmann, 2011). Coaches and athletes have long used high-intensity interval training (HIT) to improve endurance performance (Faria, 1984). While HIT appears to be an effective training technique according to anecdotal evidence, scientific support for it remains sparse (Hawley et al., 1997). This may, in part, be due to the difficulty of convincing highly trained, competitive athletes to experiment with their normal training programs (Stepto et al., 1998). Only in recent years has the influence of HIT on performance and associated physiological markers been examined in long-distance runners (Babineau and Collins et al., 2000), and endurance-trained cyclists (Westgarth-Taylor et al., 1997). Studies in runners have noted increases in 10-km run performance with reductions in lactate accumulation at submaximal workloads despite no improvement in the ventilatory threshold (Collins
et al., 2000). Recent work with endurance-trained cyclists has found improvements in peak power output (PPO), time to fatigue at 150% of PPO, and 40-km time trial performance (Lind-say et al., 1996; Westgarth-Taylor et al., 1997; Weston et al., 1997). These performance improvements have been attributed to an enhanced fat oxidation at the same absolute exercise intensity (Westgarth-Taylor et al., 1997) and improvements in skeletal muscle buffering capacity without a change in glycolytic or oxidative enzyme activity (Weston et al., 1997). Furthermore, maximum output power and average output power in the experimental group was significantly increased.

Maximal oxygen consumption, or VO2max, is thought of as the single best measure of cardiorespiratory endurance and aerobic fitness (Wilmore & Costill, 2004). The measurement of VO2 is routine in the physiological testing of elite athletes (Bosquet et al., 2002). This is because other factors contribute to an athlete’s ability to perform endurance events, such as the percentage of VO2max at which the athlete can perform, and how long the athlete can perform at that percentage of VO2max (Bosquet et al., 2002).

Naimo and et al., (2015) in a study High-intensity interval training has positive effects on performance in ice hockey players. His study investigated the effects of a HIIT program compared to traditional continuous endurance exercise training. 24 hockey players were randomly assigned to either a continuous or high-intensity interval group during a 4-week training program. The interval group (IG) was involved in a periodized HIIT program. The continuous group (CG) performed moderate intensity cycling for 45-60 min at an intensity that was 65% of their calculated heart rate reserve. Body composition, muscle thickness, anaerobic power, and on-ice measures were assessed pre- and post-training. Muscle thickness was significantly greater in IG (p=0.01) when compared to CG. The IG had greater values for both peak power (p<0.003) and mean power (p<0.02). Additionally, IG demonstrated a faster sprint (p<0.02) and a trend (p=0.08) for faster endurance test time to completion for IG. These results indicate that hockey players may utilize short-term HIIT to elicit positive effects in muscle thickness, power and on-ice performance.

In the study of Knowles and et al., (2015) Impact of low-volume, high-intensity interval training on maximal aerobic capacity, health-related quality of life and motivation to exercise in ageing men. The results stating: Average peak anaerobic power and anaerobic power increased significantly after the training and after the training showed an increase in maximum oxygen consumption.

**Materials and Methods**

Research method was quasi-experimental with design pre-test and post-test. In present study, 28 sedentary male subjects (20 to 30 years old) from university of Tabriz tended to participate. Two types of training (interval Vs. Continuous) for 4 weeks including 4 sessions a week and 45-minute duration for each session were considered as an independent variable (Interval training: 10-minute warm up, 6-9 repetition of 30-second dash-run, and Continuous training: 10-minute warm up, 30-minute running with 70%-75% reserved heart rate and 5-minute cooling down). Prior to administering independent variable, all subjects went through preparatory phase including 30-minute low intensity aerobic training (3 sessions a week). Hence, all homogenous subjects were randomly assigned to two types of training. Indices of Peak power output (PPO) and Mean power output (MPO) were measured. Having collected results, in order to observe the normality of data and effect of independent variable on dependent variables, Kolmogorov–smirnov test and repeated measure analysis of variance, independent T test at the significance level of 0.05 were used respectively.

**Results**

<table>
<thead>
<tr>
<th>sitting</th>
<th>Time (min)</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
<th>Sixth</th>
<th>Seventh</th>
<th>Eighth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>35</td>
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<td>40</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>ninth</td>
<td>Tenth</td>
<td>Eleventh</td>
<td>Twelve</td>
<td>Thirteenth</td>
<td>Fourteenth</td>
<td>fifteenth</td>
<td>Sixteenth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>45</td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>35</td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Number of occurrences of continuous aerobic exercise sessions
Table 2. Results Shapiro-Wilk test for individual characteristics and preliminary measurements (N= 20)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>S-W Amount</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>94.0</td>
<td>24.0</td>
</tr>
<tr>
<td>BMI (kg / m²)</td>
<td>9.0</td>
<td>059.0</td>
</tr>
<tr>
<td>fat percentage</td>
<td>093.0</td>
<td>.180</td>
</tr>
<tr>
<td>anaerobic power Peak (watt)</td>
<td>97.0</td>
<td>82.0</td>
</tr>
<tr>
<td>The average anaerobic power (watt)</td>
<td>95.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Table 3. Indicators for measuring subjects during the measurement (N= 10)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Step</th>
<th>Aerobic exercise</th>
<th>Anaerobic exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (kg / m²)</td>
<td>Before: 78.5±3.24</td>
<td>3.22±2</td>
<td></td>
</tr>
<tr>
<td>BMI (kg / m²)</td>
<td>After: 49.02±3.24</td>
<td>06.12±2.22</td>
<td></td>
</tr>
<tr>
<td>fat percentage</td>
<td>Before: 03.84±6.17</td>
<td>38.7±1.15</td>
<td></td>
</tr>
<tr>
<td>fat percentage</td>
<td>After: 72.85±4.17</td>
<td>7.6±3.13</td>
<td></td>
</tr>
<tr>
<td>anaerobic power Peak (watt)</td>
<td>Before: 23.5±70.555</td>
<td>26.82±97.542</td>
<td></td>
</tr>
<tr>
<td>anaerobic power Peak (watt)</td>
<td>After: 63±70.614</td>
<td>8.684±104</td>
<td></td>
</tr>
<tr>
<td>The average anaerobic power (watt)</td>
<td>Before: 48.2±77.435</td>
<td>07.9±51.393</td>
<td></td>
</tr>
<tr>
<td>The average anaerobic power (watt)</td>
<td>After: 18.14±83.461</td>
<td>87.14±49.463</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Independent t-test measurement data continuity between the two groups of aerobic and anaerobic interval before running sports contracts (N= 10)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>29.1</td>
<td>18</td>
<td>21.0</td>
</tr>
<tr>
<td>BMI (kg / m²)</td>
<td>79.1</td>
<td>18</td>
<td>.090</td>
</tr>
<tr>
<td>fat percentage</td>
<td>92.0</td>
<td>18</td>
<td>36.0</td>
</tr>
<tr>
<td>anaerobic power Peak (watt)</td>
<td>33.0</td>
<td>18</td>
<td>74.0</td>
</tr>
<tr>
<td>The average anaerobic power (watt)</td>
<td>4.1</td>
<td>18</td>
<td>170.0</td>
</tr>
</tbody>
</table>

Independent t-test measurement data before running sports show contract between each of the individual features and performance criteria before the beginning of the study there was no significant difference. 1. Response Peak power output (PPO), disabled students to the type of exercise anaerobic and aerobic continuous interval differ.

Table 5. Analysis results variance associated with the mean change in Peak power output (PPO), anaerobic and aerobic continuous interval sedentary males

<table>
<thead>
<tr>
<th>Source Change</th>
<th>Df</th>
<th>The average sum of squared deviations from the mean</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>The effect Measured steps</td>
<td>1</td>
<td>100389.37</td>
<td>40.55</td>
<td>0.00</td>
</tr>
<tr>
<td>The effect of group differences</td>
<td>1</td>
<td>8056.79</td>
<td>0.63</td>
<td>0.43</td>
</tr>
<tr>
<td>The interaction between group and measured process</td>
<td>1</td>
<td>16858.82</td>
<td>6.81</td>
<td>0.01</td>
</tr>
<tr>
<td>The effect of intra-group error</td>
<td>18</td>
<td>44554.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The effect of intergroup error</td>
<td>18</td>
<td>228089.09</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The maximum level of oxygen consumption following inactive men both anaerobic and aerobic continuous interval training significantly increased \((p=0.000)\). In addition, these differences were not statistically significant between levels of Peak power output (PPO), measurement process \((p=0.43)\).

### Table 6. Compare the difference between Peak power output (PPO), anaerobic and aerobic continuous two stages in the HIT group (independent t-test results)

<table>
<thead>
<tr>
<th>group</th>
<th>The difference between the two stages</th>
<th>t</th>
<th>Df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic</td>
<td>2.1</td>
<td>-3.11</td>
<td>18</td>
<td>0.006</td>
</tr>
<tr>
<td>anaerobic</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to the results table 6, no significant difference between the mean Peak power output (PPO), anaerobic and aerobic continuous interval between the two groups was observed immediately after exercise.

### Table 7. Analysis results variance of increased Mean power output (MPO) anaerobic and aerobic continuous periodic sedentary males

<table>
<thead>
<tr>
<th>Source Change</th>
<th>Df</th>
<th>The average sum of squared deviations from the mean</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>The effect Measured steps</td>
<td>1</td>
<td>22900.53</td>
<td>18.11</td>
<td>0.000</td>
</tr>
<tr>
<td>The effect of group differences</td>
<td>1</td>
<td>3741.71</td>
<td>0.48</td>
<td>0.49</td>
</tr>
<tr>
<td>The interaction between group and measured process</td>
<td>1</td>
<td>4804.2</td>
<td>3.8</td>
<td>0.06</td>
</tr>
<tr>
<td>The effect of intra-group error</td>
<td>18</td>
<td>1263.86</td>
<td>4.63</td>
<td>0.000</td>
</tr>
<tr>
<td>The effect of intergroup error</td>
<td>18</td>
<td>7745.49</td>
<td>7.3</td>
<td>0.000</td>
</tr>
</tbody>
</table>

### Table 8. Compare Mean power output (MPO) difference between anaerobic and aerobic continuous phase in the HIT group (independent t test results)

<table>
<thead>
<tr>
<th>group</th>
<th>The difference between the two stages</th>
<th>t</th>
<th>Df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic</td>
<td>-25.94</td>
<td>-1.95</td>
<td>18</td>
<td>0.06</td>
</tr>
<tr>
<td>anaerobic</td>
<td>-69.77</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to the results in Table 8, significant difference between the Mean power output (MPO) anaerobic and aerobic continuous alternation between the two groups was observed immediately after exercise.

Discussion and Conclusion

According study results, peak power is turned off after both men periodic anaerobic and aerobic continuous training significantly improved. Also, increased peak anaerobic power, anaerobic and aerobic continuous periodic inactive men between the two groups was significantly different.

The findings of this study to increase the maximum oxygen consumption anaerobic and aerobic continuous non-active men after two types of exercise: anaerobic and aerobic continuous.
intermittent exercise with the results Cook and colleagues (2015), Cook and colleagues (2013), lep
t and colleagues (2013), Tabata et al. (1996) and H Hickson et al (1977) is aligned. Body composition also
plays a significant role in VO2max, sometimes accounting for as much as 70% of VO2max differences (McAr
dle et al., 1986). The improvement in PPO demonstrated in the present study is important since others have
found PPO is strongly related to 40-

km time trial performance (Stepto et al., 1998; Westgarth-Taylor et al., 1997; Weston et al., 1997).
The logic behind HIIT training models is that they may produce a large adaptive response by virtue of
recruiting a broader population of muscle fibers (Gollnick et al., 1974) and by providing a larger

cardiorespiratory signal to adapt (Buchheit and Laursen, 2013a; 2013b). To the degree that there have
been large changes demonstrated in elements of muscle physiology including markers of molecular
signaling (Gibala et al., 2008, 2012) with high intensity training, this logic seems valid. Higher

intensity training is clearly advantageous for more athletic individuals who have a smaller adaptive
response window (Billat, 2001; Gunnarsson and Bangsbo, 2012; Seiler et al., 2013; Stepto et al., 1999,
Tschakert and Hofmann, 2013). However, the present results suggest, in the setting of a practical exercise
training protocol, that there is little unique advantage to HIIT protocols with minimally trained individuals.

Limitation of the study in terms of subject selection needs to be acknowledged. Recruiting truly sedentary
subjects, who are not generally interested in exercise of any form, for a study that includes the possibility of
being randomized to a quite vigorous training program is difficult. On the other hand, in a university
community, even nominally sedentary subjects may have background levels of activity that are higher than
ideal. We only accepted ~33% of subjects expressing an interest in the study. Most of those who were
rejected were either too active currently, or had a recent history of sports participation.

Recent studies have shown that high intensity intermittent training program like average continuity,
increase in transmission capacity lactate and hydrogen ions released from active muscles, the capacity to
pump sodium / potassium, as well as neural activation, increase glycogen stores, whole body fat oxidation,
glucose transport the muscles are activated and improvements in running economy.

Based on the results of this study mean anaerobic non-
active men after both anaerobic and aerobic continuous periodic training significantly improved. Also, the mean anaerobic power, anaerobic and aerobic continuous periodic inactive men between the two groups did not differ significantly.

Increase in power output after training with most research including Siyahkohian and colleagues (2013),

can be concluded that the average productivity of intense interval training (MPO) influences. The
average continuous training group, the mean scores in the pre-test and post-test, there was a significant
difference.

Exercise training protocols also have to be evaluated in terms of safety. Although exercise training is
generally quite safe (Foster and Porcari, 2008), higher intensity exercise has been shown to be a trigger for
acute myocardial infarction in middle-aged and older individuals (Franklin and Billecke, 2012) and there has
been recent concern that “excessive” volume and intensity of exercise training, in athletic individuals,
may lead to adverse cardiac remodeling (O’Keefe et al., 2015). Within this context, it seems reasonable to
suggest that HIIT protocols should be used somewhat sparingly.

The progressive loss of enjoyment across all the protocols suggests that perhaps variety in the type of
exercise is as important as the type of exercise per se. Particularly considering that the health benefits of
exercise have to be viewed in the context of the likelihood that exercise is continued for several years,
not just the weeks of a controlled study. Perhaps, in our quest to find the ‘perfect exercise’ we have missed
the more important issue of how to make exercise enjoyable enough to be continued long term.

Many high-level endurance training will already include high-intensity intervals in their training
leading up to and including the competitive phase. For these athletes adding more intervals is not necessarily
a good strategy, but altering the mix to reduce the volume of lower intensity intervals and increase the
volume of higher intensity intervals may be beneficial. Athletes who do not currently include sport-specific
explosive resistance training are almost certain to experience substantial gains in performance by adding
this form of training to their programs.

A partially selective effect of the different kinds of training on physiological measures raises the
possibility of prescribing training to correct weaknesses in these measures. Thus, we can conclude that
moderate continuous training does not influence on the peak power production girls' basketball. Results
showed that only intense interval training group, the peak power production (PPO) increased. This finding
is consistent with research Larson is aligned although most studies in this field increase anaerobic capacity
intense interval training has been shown to follow the program, but the answer is different.

Conflict of interest
The authors declare no conflict of interest.

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