The Effects of Interval Running Exercise on Acute Calorie Expenditure

Mehmet Yıldız and Zeki Akyıldız
School of Physical Education and Sports, Afyon Kocatepe University, Afyon 03200, Turkey

Abstract: Interval training is getting more attention due to the rapid improvement in fitness and health level. This is so important for the people who have no much time to spend in gym or sports areas. Therefore, burning much more calories in a short time is getting important for these busy people. The aim of this study was to investigate the effect of interval running exercises on acute calorie consumption. Thirteen female and ten male sedentary collegian students (age: 19.48 ± 1.64, height: 171.95 ± 8.14, weight: 65.91 ± 14.69) participated in the current study. All participates performed a steady state running for 30 min with 8 km/hour speed and interval running (6 km/h and 10 km/h with 1 minute interval) for 30 min on a treadmill on different days. Their calorie expenditure and other related gas parameters were measured with a mobile gas analyzer. The paired t-test was used to compare two protocols for the whole group. Moreover, the Wilcoxon test was used to measure in order to detect significant differences between steady state and interval running protocols for male and female groups. The results showed that there was no significant difference in calorie consumption, CO₂ production and RER values, while the only difference was observed in O₂ cost ($p < 0.01$) and heart rate in the whole, male and female groups ($p < 0.05$). As a conclusion, it was seen that interval running caused no more calorie expenditure than the classical steady state running acutely. Therefore, calorie burning may be delayed. There is a need for further study in this area.

Key words: Interval running, calorie, expenditure.

1. Introduction

Excessive calorie intake and a sedentary lifestyle are seen as the main reason of epidemic of metabolic syndrome which is a cluster of cardiovascular risk factors including high blood pressure, dyslipidemia, insulin resistance, and obesity [1]. Almost 300 million people have been affected from these syndromes [2]. However, it is well known that increased physical activities are the most effective and low-cost treatment for the prevention of such symptoms related with metabolic disorders [3-7]. However, most of the people are reluctant to engage in exercise because of lack of time, despite the obvious therapeutic potential of exercise interventions [8]. The other problem is what type of exercise or machines is chosen for the general health improvement. Because new training methods and machines are continually developed and often touted as being more effective than the traditional training methods.

The main goal of all these systems is to burn more calories [9]. Therefore, many studies were conducted to evaluate burning more calories according to newer aerobic devices in traditional forms of aerobic exercise [9-12], and walking methods (modified forms of walking versus regular walking or walking versus running) [13-16].

At this point, interval training is getting more attention for a better health and fitness level. During interval exercises, the body’s homeostasis is disrupted and re-established. This makes interval exercises more effective than steady state aerobic exercise because of an increasing metabolic rate following a workout [17]. It is well known that interval training reverses the risk factors of metabolic syndrome [2], decreasing cardiovascular-disease risk factors in obese adolescents [2], increasing proteins that transport fatty acids across the mitochondrial membrane [18] and have a good effect on vascular health [19]. Moreover, muscle oxidative capacity of carbohydrates and fat [20, 21].
21] and skeletal muscle enzyme activity [22-24]
increase more when compared with the traditional
continuous aerobic training (same extend).
Furthermore, it has been indicated that interval
running is seen as more motivating and it is perceived
as more enjoyable than other moderate intensity
continuous exercises [2]. These results may be so
important for the people who want to burn more
calories and have no much time to spend in gym or
sports areas.

Although it is well known that interval training
reverses the risk factors of metabolic syndrome and
has a positive effect on health, the acute effect of
interval training on calorie conception is unknown.
We support the hypothesis that by altering the body’s
homeostasis during interval exercises, the body may
burn more calories to adapt these changes and to
overcome exercises intensity. Therefore, the aim of
the current study was to investigate effect of interval
running on acute calorie consumption.

2. Material and Methods

2.1 Participants

Thirteen female and ten male sedentary collegian
students (age: 19.48 ± 1.64, height: 171.95 ± 8.14,
weight: 65.91 ± 14.69) were volunteered to participate
in the current study. The participants did not have any
serious injuries for at least six months. The study was
approved by the ethics committee of the Osmangazi
University, Turkey, in accordance with the ethical
standards of the Helsinki Declaration. A written
informed consent form was signed by all participants
before the start of the study.

The procedures are as follow. After 10 minutes of
warm-up exercise which included cycling on a bicycle
ergometer, free stretching, participants familiarized
with running on a treadmill. All of the participants
performed a classical SS (steady state) running for 30
min with 8 km/hour speed and a interval running (6
km/h and 10 km/h with 1 minute interval) for 30 min
on a treadmill with three days interval. Their calorie
expenditure and other related gas parameters were
tested using the Respiratory Gas Exchange Analyzer
VO2000 (Medgraphic, USA).

2.2 Measuring Calorie Consumption

Caloric expenditure was determined using the gas
analyzer VO2000 (MedGraphics, USA) which was
calibrated before and after each test using a 2 L
syringe and gases of the known concentration. Heart
rate measurements were carried out using a telemetry
device (Polar Oy Electro, Finland). The VO2000
measures oxygen uptake, carbon dioxide output and
exhaled air volume in liters per minute. Having these
parameters, the software calculated the consumed
energy expressed in kilocalories per minute
(kcal/min).

2.3 Statistical Analysis

Normality of the distribution was calculated with
Kolmogorov Smirnov test, and homogeneity of
variance was calculated with Levene test. A paired
t-test was used to compare two protocols for the whole
group. The Wilcoxon test was used to detect whether
there were significant differences between steady state
and interval running protocols for male and female
groups when the data were not normally distributed.
All data were expressed as mean and SD (standard
deviation), and all analyses were done through SPSS
18.0 (Statistical Package for Social Sciences, Chicago,
IL, USA).

3. Results

Table 1 shows the means and SDs of calorie
expenditure (kcal/30 min), O2 consumption (mL/min),
CO2 production (mL/min), RER and HR (bpm/min)
results. There was not any statistically significant
difference in terms of calorie consumption, CO2
production and RER when steady state and interval
running protocols were compared in total, male and
female groups. When comparing O2 (mL/min) used
during the exercises, the participants displayed
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Table 1  Comparison of steady state and interval running trials of participants [total (n = 23), female (n = 13) and male (n = 10)] for calorie burning, O₂ consumption, CO₂ production, RER and HR values.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Trials</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\bar{x}$ ± sd</td>
<td>$\bar{x}$ ± sd</td>
<td>$\bar{x}$ ± sd</td>
</tr>
<tr>
<td>Calorie (kcal/30 min)</td>
<td>SS</td>
<td>298.87 ± 64.66</td>
<td>333.50 ± 78.09</td>
<td>263.38 ± 27.83</td>
</tr>
<tr>
<td></td>
<td>Int</td>
<td>295.13 ± 63.41</td>
<td>345.70 ± 66.45</td>
<td>256.23 ± 16.97</td>
</tr>
<tr>
<td>O₂ (mL/min)</td>
<td>SS</td>
<td>1,975.60 ± 420.86*</td>
<td>2,257.80 ± 479.9*</td>
<td>1,758.53 ± 185.88*</td>
</tr>
<tr>
<td></td>
<td>Int</td>
<td>1,864.26 ± 398.99</td>
<td>2,180.20 ± 424.41</td>
<td>1,621.23 ± 97.93</td>
</tr>
<tr>
<td>CO₂ (mL/min)</td>
<td>SS</td>
<td>1,911.00 ± 440.50</td>
<td>2,178.80 ± 518.33</td>
<td>1,675.00 ± 220.15</td>
</tr>
<tr>
<td></td>
<td>Int</td>
<td>1,980.22 ± 385.28</td>
<td>2,245.90 ± 397.01</td>
<td>1,699.76 ± 115.89</td>
</tr>
<tr>
<td>RER</td>
<td>SS</td>
<td>0.95 ± 4.63</td>
<td>0.93 ± 4.86</td>
<td>0.96 ± 4.32</td>
</tr>
<tr>
<td></td>
<td>Int</td>
<td>0.98 ± 6.34</td>
<td>0.98 ± 5.75</td>
<td>0.98 ± 6.91</td>
</tr>
<tr>
<td>HR (bpm/min)</td>
<td>SS</td>
<td>165.30 ± 15.79*</td>
<td>157.80 ± 11.18*</td>
<td>171.07 ± 16.73*</td>
</tr>
<tr>
<td></td>
<td>Int</td>
<td>156.57 ± 13.05</td>
<td>148.20 ± 10.08</td>
<td>163.00 ± 11.51</td>
</tr>
</tbody>
</table>

*p < 0.05, SS: Steady state, Int: Interval, RER: Respiratory Exchange Ratio.

significantly ($p \leq 0.05$) greater O₂ consumption in steady state running (total group: 1,975.60 ± 420.86 mL/min; male: 2,257.80 ± 479.9 mL/min and female: 1,758.53 ± 185.88 mL/min separately) compared with interval running protocol (total: 1,864.26 ± 398.99 mL/min; male: 2,180.20 ± 424.41 mL/min; female: 1,621.23 ± 97.93 mL/min separately) in whole, male and female groups. Similarly, the HR was significantly ($p < 0.05$) higher during steady state running (total: 165.30 ± 15.79 bpm; male: 157.80 ± 11.18 bpm; female: 171.07 ± 16.73 separately) when compared to interval running (total: 156.57 ± 13.05 bpm; male: 148.20 ± 10.08 bpm, female: 163.00 ± 11.51 bpm, separately) in total, male and female groups.

4. Discussion

Revealing the actual energy expenditure ratio of the exercise activity is so important for the people who want to burn more calories and have no much time to spend in gym or sports areas. During interval exercises, the body’s homeostasis is disrupted and re-established. This makes interval exercises more effective than continuous aerobic exercise because of increasing metabolic rate following a workout. Although it is well known that interval training reverses the risk factors of metabolic syndrome and has a positive effect on health, the acute effect of interval training on calorie expenditure is unknown. This current study has been the first one to investigate the effect of interval running on acute calorie consumption.

Our findings showed that there was no significant difference for the total caloric expenditure when steady state and interval running protocols were compared. A hypothesis explaining these findings could be that interval running was separated as high and low intensity workout with one-minute intervals. Therefore, one-minute intervals might not be enough to reach steady state level and also to recover properly for performing another high-intensity interval during running. This might cause an increase in EPOC (excessive post-exercise oxygen consumption) which means the elevation in O₂ consumption above the resting level after exercise [25]. EPOC is initially thought to contribute to the energy cost of exercise [17]. Several factors contribute to the EPOC. First, some of the O₂ consumed early in the recovery period is used to re-synthesize store PC in the muscle and replace O₂ stores in both muscle and blood. Other factors that contribute to the “slow” portion of the EPOC include an elevated blood temperature, hormones and HR, O₂ required to convert lactic acid to glucose (gluconeogenesis) [26]. Supporting this hypothesis, Ref. [17] compared the EPOC after a sub-maximal continuous running and a supra-maximal
interval running. They found a higher post-exercise metabolic rate following an interval running (20 × 1-min at 105% VO₂ max with 2-min rest) than they did after steady state running (30-min at 70% VO₂ max). Similarly, Ref. [27] investigated the effects of steady state and interval exercise on energy expenditure and substrate oxidation over a 24-h period. They found that more calories were burnt during the 24 hours following an interval workout (15 × 2-min at 100% CO₂ max with 2-min rest periods) than the period after continuous exercise (60-min at 50% CO₂ max). Moreover, Ref. [28] compared an endurance exercise with an HIIT (high intensity interval training). Although they found significant lower energy cost at the end of the study in HIIT workout, a 9-fold greater reduction in skinfold thickness was observed in the HIIT group. Probably, HIIT heightens the of excessive post-exercise oxygen consumption known as “after burn” [29], and this may increase up regulation of enzymes responsible for beta-oxidation and the body’s potential to use lipids as an energy substrate [28].

Another finding in our study was that when comparing O₂ (mL/min) used during the exercises, the participants displayed significantly greater O₂ consumption in steady state running. Moreover, average HR was lower during the interval running than steady state running. It is well known that in the transition from rest to light or moderate exercise, O₂ consumption increases rapidly and reaches steady state within one to four minutes [30]. The energy to perform long-term exercise (i.e., more than ten minutes) comes primarily from aerobic metabolism. A steady-state oxygen uptake can generally be maintained during sub-maximal exercise of moderate duration [26]. Moreover, the time to reach steady state is shorter in trained subjects than in untrained subjects [31]. This difference in the time course of oxygen uptake at the one set of exercise between trained and untrained subjects results in the trained subjects having a lower oxygen deficit when compared to the untrained. Furthermore, it is generally believed that most of the ATP (adenosine triphosphate) production used to provide energy muscular contraction during the early stages of an incremental exercise comes from aerobic sources [26]. However, as the exercise intensity increases, blood levels of lactic acid begin to rise in an exponential fashion. This appears in untrained subjects around 50% to 60% of CO₂ max. While it occurs at higher work rates in trained subjects (i.e., 65%-80% CO₂ max) [32]. Therefore, we think that during interval running the participants had more oxygen deficit, because all participants in our study were untrained. In additionally, it has been demonstrated that heart rate begins to increase within the first second after muscular contraction begins [33]. If the work rate is constant and below the lactate threshold, a steady-state plateau in heart rate is reached within two to three minutes. However, heart rates decrease rapidly in the first minute of recovery. Therefore, it is inevitable that the heart rate is lower during in interval running when considering that interval running was separated as high and low intensity workout with one-minute intervals.

Consequently, calorie expenditure in interval running was not significantly different when it was compared with steady state running. This might cause an increase in EPOC. Therefore, calorie burning may be delayed. There is a need for further study in this area.

Acknowledgments

This study was presented as a verbal statement at the 14th International Sports Sciences Congress that was held in Antalya, TURKEY.

References


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