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Brazilian Journal of Biomotricity, vol. 6, núm. 4, diciembre, 2012, pp. 236-244
Universidade Iguaçu
Itaperuna, Brasil

Available in: http://www.redalyc.org/articulo.oa?id=93025807002
THE EFFECT OF EXHAUSTION RUNNING ON SATIETY AND PLASMA PEPTIDE YY IN HEALTHY MALES

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Submitted for publication: Apr 2012
Accepted for publication: Nov 2012

ABSTRACT
KOUSHKI, M. H.; MOLLANOVRUZI, A.; HAMEDINIA, M. R. The effect of exhaustion running on satiety and plasma peptide YY in healthy males. Brazilian Journal of Biomotricity. v. 6, n. 4, p. 236-244, 2012. Peptide YY is intestinal peptide that plays an essential role in regulating food intake and energy homeostasis. Very little is known about the effects of exhaustion running on satiety and gut peptides. We investigated the effects of exhaustion running on the feeling of satiety, plasma peptide YY, lactate and cortisol. Twenty two male (age 19.41 ± 1.66 years, BMI 21.43 ± 2 kg/m² and weight 65.24 ± 4.95 kg) performed an exhaustion session running with 60-85% intensity of maximal heart rate. Blood sampling were taken before and immediately after exhaustion running for measurement plasma lactate, cortisol and PYY. Exhaustion exercise cause significant decrease on plasma PYY (P= 0.017) and satiety (P= 0.002) and a significant increase in plasma lactate (P= 0.001). Suppression of peptide YY and decreased satiety after exhaustion exercise, showed significant positive relationship between them. Except physiological factors, other factors are involved in regulating appetite.

Key words: running exhaustion, peptide YY, satiety, lactate, cortisol.

INTRODUCTION
Maintain energy homeostasis refers to the long-term energy balance (JEQUIER and TAPPY, 1999). For remained body weight constant during a relatively long period must be exist energy balance between food intake and energy expenditure, otherwise, this balance is disturbed, resulting in loss or weight gain occurred (SAINSBURY et al., 2002). Appetite affected energy homeostasis, it play an important role in control and regulation of energy balance (CHENG et al.,
PYY is a 36-amino acid peptide so called after the tyrosine residues, Y being the abbreviation for the amino acid tyrosine, at each terminus of the peptide (TATEMOTO and MUTT, 1980). Furthermore PYY compared to other hormones more suppresses food intake (DRUCE et al., 2004). Also, the profile of PYY after food intake play an important role in regulate satiety in short and long time (LE ROUX et al., 2006). In addition to contributing to postprandial satiety, several emerging lines of evidence suggest that PYY plays a role in long-term body weight regulation (KARRA et al., 2010). Shifted much of the focus of the research on this new peptide to its roles in energy homeostasis. It appears that this peptide are not controlled with adipose tissue, unlike adipokines such as leptin and adiponectin (CUMMINGS and OVERDUIN, 2007).

On the other hand, physical activity has a potential impact on the feeding behavior (MARTINS et al., 2008). Physical activity can indirectly modulate appetite and food intake (MARAKI et al., 2005). Quantitative studies have been done on short- and long-term exercise on circulating blood levels of peptides in appetite and satiety. The precise effect of exercise unknown on PYY is still completely (BROOM et al., 2009). Several studies had investigated the influence of exercise bouts on plasma PYY concentration (BROOM et al., 2009, SALSEN et al., 1994, CHENG et al., 2009, RUSSELL et al., 2006, RUSSELL et al., 2009, UEDA et al., 2009). Most of these studies indicate that exercise increase PYY concentrations (CHENG et al., 2009, RUSSELL et al., 2006, ANDERRSON et al., 2005, RUSSELL et al., 2009, UEDA et al., 2009). Although two studies reported that PYY levels has no significant change after exercise (BROOM et al., 2009, SALSEN et al., 1994) and another studies show decrease after exercise (ANDERRSON et al., 2005). Ueda (2009) investigated effect of cycled for 60 minutes with the 50% maximum oxygen consumption on PYY levels. Physical activity cause of increased in plasma PYY levels (UEDA et al., 2009). In contrast to these results, Salsen (1994) investigated that whether increased plasma PYY concentrations in response to food intake and physical exercise? In this study, subjects survey after food intake and intense exercise. The results showed increased plasma PYY after food intake, but remained unchanged after exercise (SALSEN et al., 1994).

About effect of exercise on feelings of fullness, most studies show that vigorous exercise does not increase hunger and energy intake. In fact has been observed that suppresses hunger by intense exercise (MARTINS et al., 2007, BROOM et al., 2009, UEDA et al., 2009, KING et al., 2010). It is a phenomenon called exercise-induced anorexia (MARTINS et al., 2007). But some studies had shown increase on appetite by exercise (BELLISSIMO et al., 2007, MARAKI et al., 2005). Therefore, there is need to more research.

On the other hand, metabolic substances and other hormones like lactate and cortisol, which also can have an effect on feelings of satiety and plasma PYY concentrations. Lactate derived from the trained muscles can produce to the brain anti-appetite signals (SONG and ROUTH, 2009). Evidence also suggests that cortisol has a direct effect on appetite (TATARANNI et al., 1996) and
stimulates food intake in humans directly (GEORGE et al., 2009). It seems to increase cortisol concentration cause increase neuropeptide Y secretion and reduced of leptin on suppression food intake. Overall, increase in food intake could be affected by cortisol secretion (TORRES and NOWSON, 2007). According to available data and research literature, there is not clear information about the relationship between exhaustive running and feelings of satiety, PYY, plasma lactate and cortisol. Therefore, the purpose of this study was investigated the effect of exhaustion running on satiety and plasma PYY, lactate and cortisol in healthy males.

MATERIALS AND METHODS

Subjects

Twenty two male volunteer's students (age 19.41 ± 1.66 years, BMI 21.43 ± 2 kg/m² and weight 65.24 ± 4.95 kg) were participated in this study (table 1). All subjects completed informed consent form. The experimental protocol was approved by the local university ethics committee (Sabsevar Tarbiat Moallem University petrochemical ethic committee) and all subjects were informed of the risks and purposes of the study before their written consent was obtained. They not had taken any medication. The subjects were nonsmokers and they had a sedentary life style and were not dieting to lose weight. This was assessed through an exercise history of 3 months prior to the study.

Table 1 - Anthropometric and physiological characteristics of study subjects (mean ± SD)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight (kg)</td>
<td>65.24 ± 4.95</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>21.43 ± 2</td>
</tr>
<tr>
<td>VO₂max (ml.kg⁻¹.min⁻¹)</td>
<td>41.56 ± 4.85</td>
</tr>
</tbody>
</table>

Experimental design

According to research plan schedule, one week before the exhaustion exercise, anthropometric and physiological factors were measured including weight, body mass index and maximal oxygen consumption (Table 1). To determine maximum oxygen consumption (VO₂max), all subjects performed the 12-min Cooper's running and walk test. The following equation was used to determine maximum oxygen consumption (COOPER, 1968): VO₂max = (D – 504)/45, (D: running distance).

Participants were also asked to refrain from vigorous exercise 72 h prior to the main trials. Water was available ad libitum during trial. Blood samples were collected before and immediately after exhaustion exercise to determine levels of PYY, plasma lactate and cortisol. Also, were calculated changes in plasma volume (DILL and COSTILL, 1974) and them was corrected with changes in plasma volume.

Rating of perceived feeling of satiety
For measurement the feeling of satiety was used appetite questionnaire with visual analogue scale measurements (VAS) (FLINT et al., 2000). The feeling of satiety was measured before and after exhaustive exercise and also before dinner. The questionnaire was designed based on the following question:

- How are you feeling full?

**Main trial (Exhaustion exercise session)**

Participants arrived at the sport hall between 15:00 and 15:30. They were none fasted. Exhaustion running sessions was in the course of three minutes and 30 to 60 s active rests between periods. Subjects had started to run with 60% of maximum heart rate. In each period increase 5% intensity of activity until arrived 85% maximum heart rate. In this intensity, the subjects continued activity until to receive Exhaustion. Perceived exertion was recorded by using Borg scale (BORG, 1985). Heart rate (HR) was measured continuously using a HR monitor (Polar F1 – Polar Electro Oy, Finland).

**Blood sampling**

Blood samples (10 ml) were collected at 2.5 hours after lunch, before and immediately after exercise. 2 ml of blood were collected into micropipettes for measurement of hemoglobin concentration, and determination of hematocrit. Hemoglobin and hematocrit values were used to assess plasma volume changes. Aprotinin and EDTA were used respectively, as the protector and the separated plasma. Blood samples were centrifuged for 10 minutes at 3500 rpm. Blood samples were stored at -80 °C of peptide YY, lactate and cortisol for analysis later.

**Blood biochemistry**

Total PYY concentrations were determined by ELISA (USCN Life Science, Inc., Wuhan, China). The within-batch coefficient of variation (CV) was 6.2%. Plasma cortisol concentrations were determined by ELISA (Diagnostics Biochem Canada Inc., Ontario, Canada). The within-batch CV was 5.9%. Plasma lactate concentrations were determined by enzymatic, colorimetric methods (Randox, Antrim, United Kingdom). The within-batch CV was 2.2%.

**Statistical analysis**

Data were analysis using the Statistical Package for Social Sciences (SPSS) software ver. 18.0 for Windows (SPSS, Chicago, IL, USA). For statistical analysis, paired – samples T test was used in two stages, including before and after exhaustion exercise. Also, changes in satiety were assessed by repeated measure ANOVA. Statistical significance was accepted at the 5% level. Results are given as means ± SE.
RESULTS

Feeling of satiety

The amount of satiety was significantly decrease after exercise (P= 0.002).

Total PYY

The results showed that exercise significantly decrease of plasma PYY (P= 0.017).

Lactate and cortisol

Also, plasma lactate concentration significant increase after exercise (P= 0.001) but no significant changes in plasma cortisol levels (P= 0.80)(table 2).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre exercise</th>
<th>Post exercise</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peptide YY (pg/ml)</td>
<td>151.44 ± 19.32</td>
<td>134.43 ± 19.10*</td>
<td>0.017</td>
</tr>
<tr>
<td>lactate (mg/dl)</td>
<td>20.83 ± 5.91</td>
<td>51.08 ± 11.86*</td>
<td>0.001</td>
</tr>
<tr>
<td>cortisol (µg/dl)</td>
<td>16.44 ± 4.47</td>
<td>16.12 ± 5.51</td>
<td>0.8</td>
</tr>
</tbody>
</table>

(*) Significant at p< 0.05.

DISCUSSION

The results showed that exhaustive exercise significantly reduce in plasma PYY (P= 0.017). The results of Anderson et al (2005) are consistent with our study. They investigated effects of 30 or 60 min of running with speed of 22 m/min on the treadmill in male mice. Mice were killed after exercise in conditions of fasting or after 60 min recovery, or when it was given glucose. The results showed that PYY3-36 levels after exercise, no significant change, but 60 min after exercise PYY3-36 concentrations significantly decreased, on fasting and non-fasting conditions. In addition, the increased PYY levels after exercise (CHENG et al., 2009, RUSSELL et al., 2006, ANDERRSON et al., 2005, RUSSELL et al., 2009, UEDA et al., 2009) and no change (BROOM et al., 2009, SALSEN et al., 1994) inconsistent with our results. Martins (2007) investigated effects of 60 min exercise on PYY concentration. Temporary increase was observed during exercise in PYY concentrations (MARTINS et al., 2007). Martins during and after exercise measured PYY levels several times, that can better show changes hormonal pattern. But in the present study, PYY levels were measured only immediately after exercise, that likely may be covered the hormonal changes. Broom (2009) investigated effects 60 min running exercise on plasma levels of peptide YY. Aerobic exercise increased plasma PYY levels remained after exercise (BROOM et al., 2009), but this increase unlike the results of Martins study (2007). In Broom study (2009) increased plasma PYY levels stated suppression of hunger. Furthermore, different in time and number of measurement PYY levels can be of reasons likely. Ueda (2009) investigated 60 min of exercise on PYY level.
The results of them showed increase in PYY levels after exercise (UEDA et al., 2009). Used ergometer bike in Ueda study (2009) can be likely cause of differences between the results.

In addition, results showed significantly decrease in feeling of satiety after exhaustion exercise (P= 0/002). Consistent with our results, Maraki (2005) reported increased in appetite after an exercise session (MARAKI et al., 2005). In Maraki study (2005) exercise protocol was including aerobic exercise and fitness workouts. Type of training protocol reported cause of increased appetite (MARAKI et al., 2005). Inconsistent with our results, King (1997) and Pomerleau (2004) observed no change in the appetite response to exercise. King (1997) investigated the effect of running with 70% of maximum oxygen consumption on the treadmill, and observed no changes in appetite on day exercise and the day after exercise. Pomerleau (2004) observed no change in appetite in women after running with 40% and 70% peak oxygen consumption on treadmill. Different results could be different in subjects, age, time of measurement of appetite and exercise protocol. Broom (2007 and 2009) and King (2010) reported reduced in appetite after high-intensity aerobic exercise that is not consistent with our results (KING et al., 1997, BROOM et al., 2007, BROOM et al., 2009). Broom (2007) was reported suppresses hunger during and immediately after exercise for 60 min with 75% VO2max. The reason for this suppression, reported a significant reduction in plasma acylated ghrelin (BROOM et al., 2007). King (2010) observed the same results. The researcher was observed also suppresses hunger during and immediately after 90 min of running with the 68/8% VO2max, that suppression of acylated ghrelin reported cause of decrease in hunger (KING et al., 2010). Different study of protocol including duration, intensity, distance and energy cost of exercise was different in results.

**PRACTICAL APPLICATION**

The results showed that exhaustion exercise decrease plasma PYY, amount of satiety, while exhaustion exercise increases plasma lactate and no change in plasma cortisol. Thus it seems that energy homeostasis and regulation appetite affected by exhausting exercise, which need more research.

**REFERENCES**


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