

The Effects of Concurrent Resistance and Endurance Exercise on Hunger Feelings and PYY in Obese Men

Amir Taghipour Asrami¹, Hassan Faraji^{2*}, Seyedeh Fatemeh Jalali³

1- Sama Technical and Vocational Training College, Qaemshahr Branch, Islamic Azad University, Qaemshahr, Iran. (PhD candidate in Exercise Physiology)

2- Department of Physical Education and Sports Science, Mariwan Branch, Islamic Azad University, Mariwan, Iran. (PhD candidate in Exercise Physiology)

3- Education office of Sari, Area 1, Sari, Iran. (MSc in Physical Education & Sports Science)

*Corresponding Author, Email: farajienator@gmail.com

Abstract

Purpose: Exercise could reverse the positive energy balance by increased energy expenditure and hunger suppresses. Hormones that play a role in appetite involved in the brain-gut axis of eating behavior come from different sources. No studies have examined the effect of acute concurrent exercise on hunger and PYY. Our purpose was to investigate the effects of a bout concurrent exercise on hunger feelings and plasma PYY in obese men.

Materials and Methods: Twelve-four untrained obese male were volunteered to participate in this study. Participants after eating standard breakfast, performed 7 resistance exercises against resistance corresponding to 60% of 1RM bout then ran on the cycle ergometer for 30 minutes at 60% of maximum heart rate in a random cross-over fashion. Venous blood sample was obtained in pre exercise and 30min post exercise bout. Visual analogue scales (VAS) used to assess subjective hunger sensations. Data were analyzed by Student's paired and unpaired t-tests. Statistical significance was set at $P < 0.05$.

Results: There was a significant increase in plasma PYY concentration at post exercise compared with pre exercise and control ($p = 0.038$). Hunger scores were significantly decreased 30-min following the exercise period in experimental group ($p = 0.003$).

Conclusion: Our results showed that plasma PYY concentration increased and hunger depressed following a combined resistance and aerobic exercise at 60% of 1RM or HRmax in obese men. Therefore, increased plasma PYY concentration after a single concurrent exercise session in obese men may possibly contribute to hunger (appetite) suppression.

Keywords: Obesity, Appetite, Concurrent exercise, Moderate exercise, Anorexia.

Introduction

Over the last decades, obesity is a major health problem and is the result of positive energy balance where, over time, energy intake exceeds energy expenditure (Lofrano-Prado et al., 2012). The benefits of exercise in the prevention of overweight and obesity are well documented (Meyer et al., 2012). Exercise is an effective way of increasing energy expenditure (American College of Sports Medicine, 2001), and it may lead to a short-term hunger suppression (Broom et al., 2009; Blundell et al., 2003). Therefore exercise could reverse the positive energy balance by increased energy expenditure and hunger suppresses (Bilski et al., 2009).

Hormones that play a role in appetite involved in the brain-gut axis of eating behavior come from different sources. Some hormones, such as leptin, cholecystokinin (CCK), glucagon-like peptide (GLP), ghrelin, peptide YY, and neuropeptide Y, arise from the brain or gastrointestinal tract (Gueugnon et al., 2012). Some of these hormones suppress eating behavior (hunger control), while others stimulate it. Especially, the peptide YY

(PYY) is of interest because they appear to control hunger and food intake for up to 24-hours (Wren et al., 2001). PYY is a 36-amino acid peptide that is synthesized and released from specialized enteroendocrine cells called L-cells found predominantly within the distal gastrointestinal tract (Karra et al., 2009). Recent studies focused on aerobic or resistance exercise have revealed the inhibitory effects of acute exercise on the hunger associated with this hormone in healthy subjects (Cheng et al., 2009; Martins et al., 2007). Some studies showed that a bout of aerobic exercise caused increases in the plasma levels of PYY, and decreases in subsequent energy intake (Ueda et al., 2009a, b). Broom et al (2009) found a suppression of hunger with resistance and aerobic exercise.

Concurrent exercise that combines weight and aerobic exercises is a key component of exercise recommendations for weight control, obesity and public health (Andrade et al., 2008), thus, it is important to clarify the effects of concurrent exercise on hunger and PYY hormone. Nevertheless, no studies have examined the effect of acute concurrent exercise on hunger and PYY. Therefore, the aim of the present study was to investigate the effects of a single concurrent exercise on hunger feelings and plasma PYY in obese men.

Materials and Methods

This is a quasi-experimental research with pre-test and post-test as well as experimental and control groups in random cross-over manner. This is also an applied research. Twelve-four obese male volunteers were recruited for this study. The physical characteristics of the subjects were age, 20.81 ± 2.51 yr; body mass index (BMI), 30.22 ± 2.51 kg/m²; body fat percent, 27.67 ± 4.68 . Participants were nonsmokers, had no known history of cardiovascular/metabolic disease, not taking any medication, and had no food allergies. The Institutional Review Board of the University approved the study protocol. The participants gave a written informed consent after receiving an interpretation of the protocols and risk involved.

Before main experimental tests, subjects visited the laboratory to familiarization sessions and initial testing. Body composition was determined by bio-impedance method (In Body 3.0). One week after 1RM test session at 7 exercises (bench press, lat pull-down, hamstring curl, shoulder press, leg press, leg extension, seated cable row), participants were performed 7 resistance exercises against resistance corresponding to 60% of 1RM bout then ran on the cycle ergometer for 30 minutes at 60% of HR_{max} (maximum heart rate) in random cross-over manner and supervised in two sessions.

Participants came to the laboratory at 8h and after a 10 min rest, then fasting venous blood sample) was taken. Then a standard breakfast (560 kcal, 18.6 g protein, 21.6 g fat, and 72.3 g carbohydrate) was served at 8:20 h. At 10:30 h, the subject either exercised. During these sessions, blood samples were obtained before exercise and 30 min after the end of the exercise. The HR_{max} calculated from 220-age equation. Participations in resistance exercise performed 3 sets of 10 repetitions, and an interval of 30s between the sets and 60s between the exercises.

In order to assess subjective hunger sensations, visual analogue scales (VAS) are used (Flint et al., 2000). The questionnaire consisted of six visual analogue scales to desire to eat, urge to eat, how much you can eat now, rate hunger, preoccupation with thoughts of food, and fullness. VAS was measured by hand, from left (minimum score of 0 mm) to right (maximum score of 100 mm) (Lofrano-Prado et al., 2012). In this study we used only hunger ratings. Plasma total PYY was analyzed using standard Kit (USCN Life Science Inc).

Statistical analyses

Data were analyzed by Student's paired and unpaired t-tests. Statistical significance was set at $P < 0.05$. All analysis was performed in SPSS for Windows (version 19.0). All the data were reported as mean \pm SD.

Results

All subjects completed the exercise protocols. At baseline, all the parameters were similar between the concurrent and control exercise groups ($p > 0.05$). As shown in table 1. There was a significant increase in plasma PYY concentration at 30min post exercise compared with pre exercise and control group ($p = 0.038$). Hunger scores were significantly decreased following the 30-min exercise period compared with pre exercise in experimental group ($p = 0.003$).

Table 1: Plasma PYY concentration and hunger levels at Pre and 30m Post-exercise

Group	PYY (pg/mL)		Hunger scores	
	Pre exercise	30min post exercise	Pre exercise	30min post exercise
Concurrent	128.68±23.40	139.52±38.73*†	64.19±3.54	50.73±6.18*†
		* p = 0.038		* p = 0.003
		† p = 0.016		† p = 0.023
Control	126.17±21.73	129.42±26.33	64.41±3.82	66.47±4.11
		p = 0.83		p = 0.97

* Significant difference with Pre exercise at p<0.05

† Significant difference with control group at p<0.05

Discussion and Conclusion

A number of efforts over a few decades have attempted to investigate the feelings of hunger and some controller hormones of hunger after exercise. Exercise can contribute to successful energy balance by increased energy expenditure and hunger depress. This study examined the acute effects of concurrent exercise on hunger state and plasma PYY in obese men. The main findings of the current study are 1) acute concurrent exercise decrease hunger felling; 2) concurrent exercise increase plasma PYY concentration. Some previous studies suggest that acute exercise leads to suppressed feelings of hunger and a delay in food intake (exercise-induced anorexia) (Blundell et al., 2003).

Broom et al (2009) investigated the effects of resistance and aerobic exercise on hunger and circulating levels of the gut hormones acylated ghrelin and peptide YY (PYY) in eleven healthy male students. In this study, subjects performed resistance exercise for 90-min free weight lifting session followed by a 6.5-h rest period, and other group, cycled 60-min followed by a 7-h rest period. The study demonstrated that hunger is suppressed during and for a short while after resistance and aerobic exercise. However, this effect has not yet been studied using concurrent exercise. Our results showed that 7 resistance exercises against resistance corresponding to 60% of 1RM bout then ran on the cycle ergometer for 30 minutes at 60% of HRmax depress hunger in obese men.

The common belief is that low to moderate intensity (40-59% VO₂max) exercise is the most appropriate exercise prescription for the prevention and treatment of obesity (Carey, 2009), on the other hand, some studies showed that intense (≥ 60% VO₂max) exercise caused a post exercise suppression of hunger although low intensity exercise did not cause the same effect on hunger (Blundell et al., 2003; Blundell et al., 2000). Interestingly, we showed that combined resistance and aerobic exercise at 60% of 1RM or HRmax depressed hanger in obese subjects. This result is novel and its reasons is unclear, however a possible explanation for the current findings may be that the subjects of the present study were younger and fat than many other studies. Another possibility is that combined resistance and aerobic exercise evoked different hormonal hunger-related (appetite-related) response than resistance and aerobic exercise when performed alone.

The PYY are of particular interest because they are thought to be short-term regulators of hunger and food intake (Cummings and Overduin, 2007). The PYY is secreted predominantly from L-cells of the distal gastrointestinal tract and exert its effect through the arcuate Y receptors resulting in inhibition of NPY neurons and food intake (Gueugnon et al., 2012). The finding of the present study showed that a single exercise session increased plasma PYY concentration at 30min post-exercise. Broom et al (2009) observed significant elevation in post-exercise plasma PYY level during and for a short time after exercise response to an one bout of aerobic exercise (60 min run at a speed 70% of VO₂max on treadmill) in healthy males. Moreover, Ueda et al (2009) reported significant increase in plasma PYY levels after cycling exercise at 50% of VO₂max in obese young males. Recently, Ueda et al (2013) reported significant increase in PYY concentration after 60 min of cycling at 65% of max heart rate (MHR) (1 h after breakfast) in middle-aged women. Meyer et al (2012), in contrast to our results, were not able to change in PYY after 60 min run or walk at 70% of VO₂max, in nine middle-aged women runners. This contrasting finding may be explained by the different in subjects' age, sex, nutrition states, fitness level and obese states. Although several mechanisms have been proposed to explain 'exercise-induced anorexia' (Westerterp-Plantenga et al., 1997), the reason for this phenomenon remains unknown. However, most attention has focused on PYY since this hormone is known to have strong appetite-suppressing effects (Neary, 2009).

Given that hunger (appetite) are influenced by PYY signal (Karra et al., 2009), in the present study PYY level was measured and results showed that a single concurrent exercise session increased plasma PYY level and depressed hunger post exercise. Suppressed hunger after concurrent exercise may be due to increased plasma PYY in obese men. Our study has some limitations. We did not assess food intake measurements into

the recovery period which could have provided additional importance. Moreover, changes in hunger scores do not necessarily lead to the expected changes in food intake. In conclusion our results showed that plasma PYY concentration increased and hunger depressed following a combined resistance and aerobic exercise at 60% of 1RM or HRmax in obese men. Therefore, increased plasma PYY concentration after a single concurrent exercise session in obese men may possibly contribute to hunger (appetite) suppression.

Acknowledgements

This study was supported by the research grant from Qaemshahr Branch, Islamic Azad University, to Mr Amir Taghipour Asrami.

References

- American College of Sports Medicine, 2001. Appropriate intervention strategies for weight loss and prevention of weight regain for adults. *Med Sci Sports Exerc*, 33, 2145-2156.
- Andrade N.V, Gonçalves R.N, Monteiro L.L, Pereira E.F, 2008. Concurrent training: a review. *Ensaio e Ciência*, 12, 17-33.
- Bilski J, Teleglów A, Zahradnik-Bilska A, 2009. Effects of exercise on appetite and food intake regulation. *Med Sportiva*, 13, 82-94.
- Blundell J.E, Stubbs R.J, Hughes D.A, Whybrow S, King N.A, 2003. Cross talk between physical activity and appetite control: does physical activity stimulate appetite?. *Proc Nutr Soc*, 62, 651-661.
- Broom D.R, Batterham R.L, King J.A, Stensel D.J, 2009. Influence of resistance and aerobic exercise on hunger, circulating levels of acylated ghrelin and peptide YY in healthy males. *Am J Physiol Regul Integr Comp Physiol*, 296, 29-35.
- Carey D.G, 2009. Quantifying differences in the "fat burning" zone and the aerobic zone: implications for training. *J Strength Cond Res*, 23, 2090-2095.
- Cheng M.H, Bushnell D, Cannon D.T, Kern M, 2009. Appetite regulation via exercise prior or subsequent to high-fat meal consumption. *Appetite*, 52, 193-198.
- Cummings D.E, Overduin J, 2007. Gastrointestinal regulation of food intake. *J Clin Invest*, 117(1), 13-23.
- Flint A, Raben A, Blundell J.E, Astrup A, 2000. Reproducibility, power and validity of visual analogue scales in assessment of appetite sensations in single test meal studies. *Int J Obes*, 24(1), 38-48.
- Gueugnon C, Mougín F, Nguyen N.U, Bouhaddi M, Guénat M.N, Dumoulin G, 2012. Ghrelin and PYY levels in adolescents with severe obesity: effects of weight loss induced by long-term exercise training and modified food habits. *Eur J Appl Physiol*, 112, 1797-1805.
- Karra E, Chandarana K, Batterham R.L, 2009. The role of peptide YY in appetite regulation and obesity. *J Physiol*, 15(1), 19-25.
- Lofrano-Prado M.C, Hill J.O, Silva H.J.G, Freitas C.R.M, Lopes-de-Souza S, Lins T.A, 2012. Acute effects of aerobic exercise on mood and hunger feelings in male obese adolescents: a crossover study. *Int J Behav Nutri and Phy Act*, 9: 38.
- Martins C, Morgan L.M, Bloom S.R, 2007. Effects of exercise on gut peptides, energy intake and appetite. *J Endocrinol*, 193(2), 251-258.
- Meyer D.E.L, Palm S, Bansal A, Austin K.J, Hart A.M, Brenda M.A, 2012. Influence of running and walking on hormonal regulators of appetite in women. *J Obes*, 2012, 1-15.
- Neary M.T, Batterham R.L, 2009. Peptide YY: food for thought. *Physiol Behav*, 97, 616-619.
- Pomerleau M, Imbeault P, Parker T, 2004. Effects of exercise intensity on food intake and appetite in women. *Am J Clin Nutr*. 80(5):1230-1236.
- Ueda S, Miyamoto T, Nakahara H, Shishido T, Usui T, Katsura Y, 2013. Effects of exercise training on gut hormone levels after a single bout of exercise in middle-aged Japanese women. *SpringerPlus*, 2, 83.
- Ueda S, Yoshikawa T, Katsura Y, Usui T, Fujimoto S, 2009a. Comparable effects of moderate intensity exercise on changes in anorectic gut hormone levels and energy intake to high intensity exercise. *J Endocrinol*, 203, 357-364.
- Ueda S, Yoshikawa T, Katsura Y, Usui T, Nakao H, Fujimoto S, 2009b. Changes in gut hormone levels and negative energy balance during aerobic exercise in obese young males. *J Endocrinol*, 201(1), 51-59.
- Westerterp-Plantenga M.S, Verwegen C.R, Ijzerman M.J, Wijckmans N.E, Saris W.H, 1997. Acute effects of exercise or sauna on appetite in obese and nonobese men. *Physiol Behav*, 62, 1345-1354.
- Wren A.M, Seal L.J, Cohen M.A, Brynes A.E, Frost G.S, Murphy K.G, 2001. Ghrelin enhances appetite and increases food intake in humans. *J Clin Endocrinol Metab*, 86(12), 5992-5996.