Chapter 6

Acute Effects of High-Intensity Exercise on Energy Intake and Appetite Suppression in Obese Males

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ABSTRACT

High intensity exercise has been shown to reduce energy intake by supressing appetite response. However, the effect of different high intensity exercise modalities is relatively unknown. **Objective:** To investigate the acute effect of high intensity aerobic and resistance exercise on energy intake, appetite suppression and blood glucose level among obese individual. **Method:** Twelve obese participants (age 20.8±1 yr, BMI: 34.1±3 kg/m2, VO^2 max 30.7±3 ml/kg/min) completed a crossover study with an interval of one week between two 30 min trials in a random order. Participants were required to completed, (1) High Intensity Aerobic Exercise (HIAE) - exercise on cycle ergometer for 30 minutes (80-95% of HRmax), (2) High Intensity Resistance Exercise (HIRE) – completed 8 different exercise of weight lifting (80% of 1RM) and (3) control group – condition after a 10 hour overnight fast except for water. Each participant has answered the Three Factor Eating Questionnaire-R18 (TFEQ-R18), Visual Analog Scale (VAS) of appetite rating, measured blood glucose level and food intake recorded for 24 hours. All data were collected two times (before and after exercise). **Result:** A significant different between group on energy intake and uncontrolled eating ($p < 0.05$) were noted. **Conclusion:** In response to acute exercise, both HIAE and HIRE shows significant reduction of energy intake and improvement in appetite suppression. However, the effects of HIAE is superior compare to HIRE.

Key Words: high-intensity exercise, appetite suppression, aerobic exercise, resistance exercise and obesity

1. INTRODUCTION

The prevalence of obesity has reached epidemic occurrence worldwide, with more than 1.6 billion adults overweight (BMI >25kg/m^2) and at least 400 million clinically obese (BMI >30kg/m^2) (World Health Organization, 2010). Major factor that lead to obesity is energy imbalance where energy intake is not equal to energy expenditure (Balaguera-Cortes et al., 2011). It is generally accepted that the increasing amount of obesity is due to increase energy intake that parallel with reduction in physical activity or exercise. It is important to

note that the exercise itself have an influence on the total amount of energy intake. The effect of exercise on subsequent energy intake has been found to be influenced by characteristic of the exercise bout, such as intensity and duration (King et al. 1997b; Kissileff et al. 1990; Pomerleau et al., 2004; Balaguera-Cortes et al., 2011). Besides, another factor that may influence the appetite suppression effect is the modalities of exercise performed. Vigorous exercise (high-intensity cycling or running) has been found to significantly reduce hunger during post-exercise (Martins et al., 2008). Several studies have demonstrated increased in fasting and postprandial levels of the satiety hormone pancreatic polyetide (PP) which promote appetite suppression after aerobic exercise (Dengel et al., 1996; Snowling and Hopkins, 2006; Pratley et al., 2000). In other study done by Broom et al., (2008) and Ballard et al. (2009) appetite suppression also can be obtained from resistance exercise. The appetite suppression effect improves blood glucose level following exercise (Pratley et al., 2000; Rice et al., 1999; Dengel et al., 1996). High intensity exercise has been shown to reduce energy intake by supressing appetite response. However, the effect of different high intensity exercise modalities is relatively unknown. Therefore the purpose of this study is to investigate the acute effect of high intensity aerobic and resistance exercise on appetite suppression and blood glucose level among obese individual.

2. METHOD

Participants

Twelve obese participants (age 20.8±1 yr, BMI: 34.1±3 kg/m^2, VO_2 max 30.7±3 ml/kg/min) completed crossover study with an interval of one week between two 30 min trials in a random order. The study was approved by the Research Ethics Committee (FSR/SR243/038/2018) and conformed to the code of ethics of the Declaration of Helsinki. Participants were thoroughly informed of the protocol and the possible risks and benefits of participation before written informed consent were obtained.

Study Design

During preliminary visit, the risk and flow of the experimental test were explained and participants were required to complete, (1) High Intensity Aerobic Exercise (HIAE) - exercise on cycle ergometer for 30 minutes (80-95% of HRmax), (2) High Intensity Resistance Exercise (HIRE) – completed 8 different exercise of weight lifting (80% of 1RM) and (3) control group. Experimental testing pre-post tests were performed on different days with 7 days interval. Variable measured included energy intake, subjective appetite response on a visual analog scale (VAS), the Three Factor Eating Questionnaire-Revised 18-items (TFEQ-R18) and blood glucose level.

Pre-experimental assessment

Antropometric measurement (BMI), body fat measurement [Bioelectrical Impendence Analysis (BIA), r=0.96] and beep test (VO_2 max), VO_2 max were calculated ; VO2max = 43.313 + 4.567*sex – 0.560*BMI + 2.785*stage (r=0.86) [sex: male = 1 & female = 0] (Silva et al., 2012)

Experiment trials

Participants were required to record all food and drink consumption to measure normal energy intake. Before experimental trials, participants were required to fast for 10 hours except for water. On the morning of each experimental trials, fasting blood glucose were taken and each participant was provided with standardized breakfast (~442 kcal). The participants were asked to answer Three Factor Eating Questionnaire-R18 (TFEQ-R18), Visual Analogue Scale (VAS). 1 hours after the breakfast session, participants were either

performed exercise on cycle ergometer for 30 minutes with target 80 – 95% of HRmax for aerobic exercise or completed 8 different exercise of weight lifting with target 80% of 1RM for resistance exercise or control test (rest for 60 minutes). After completed experimental trials, blood glucose and VAS was measured immediately for subjective appetite perception. Participants were provided with standardized lunch (~800 kcal). Participants were instructed to fill in the TFEQ-R18 and record post-exercise dietary intake.

Instrumentation

100mm visual analogue scale (VAS) (Flint et al., 2000) has been used to measure the rate of hunger as appetite response. The questions are divided into 2 types (a) questions on appetite b) questions on palatability of test meals. Three factor eating questionnaire 18 items (TFEQ-R18) (Blandine de Lauzon et al., 2004) were used in this study to measured eating behaviour of the subject. TFEQ-R18 version comprises 3 different scale corresponding to cognitive restraint (CR), emotional eating (EE), and uncontrolled eating (UE). 24-h food diary is been used to measure dietary energy intake pre-post exercise testing. All information from dietary intake were calculated and converted into kilo calorie (kcal) following the guidelines references from the Ministry of Health Malaysia. Blood glucose monitor been used to measure participants blood glucose response (One Touch Model Ultra, LifeScan, Milpitas, California).

Statistical Analysis

Descriptive statistics was used to report the findings of this study. The main data analysis in present study was analysed using (ANOVA: Repeated Measures, Within Between Interaction). Analysis of data was conducted using Statistical Packaging for Social Science (SPSS) with significant accepted at P<0.05.

3. RESULT

Table 1 Overall results of this study

	HIAE		HIRE		Control				
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**F(df)**	**Between**	**Within**
Dietary Intake (kcal)	2476.7 ± 261.4	1044.2 ± 338.9	1413.5 ±155.6	963.4 ± 263.4	2297.0 ± 212.8	2329.5 ± 265.1	F(1,33)= 213.9	p <.05*	p <.05
Cognitive Restrain	34.7 ± 29.7	45.2 ± 26.4	44.4 ± 12.5	60.4 ± 16.3	30.0 ± 33.6	59.7 ± 26.1	F(1,33)= 13.5	p >.05	p <.05
Uncontrolled Eating	37.0 ± 14.3	57.9 ± 20.0	66.7 ± 20.1	45.6 ± 12.8	45.6 ± 12.8	54.4 ± 12.6	F(1,33)= 0.9	p <.05*	p >.05
Emotional Eating	41.7 ± 18.0	56.9 ± 11.1	39.8 ± 13.8	68.3 ± 15.9	19.4 ± 33.2	25.0 ± 15.1	F(1,33)= 15.8	p >.05	p <.05
Visual Analog Scale (VAS)	48.8 ± 9.9	45.4 ± 7.4	47.5 ± 5.4	51.0 ± 6.9	48.8 ± 4.3	48.1 ± 3.9	F(1,33)= 0.009	p >.05	p >.05
Blood Glucose	4.8 ± 0.5	5.2 ± 0.6	4.8 ± 0.3	4.9 ± 0.3	4.9 ± 0.2	5.1 ± 0.3	F(1,33)= 9.2	p >.05	p <.05

* Significant interaction between groups p<.05

Table 2 Pairwise comparison between groups

			Mean Different	Sig
Dietary Intake	HIAE	Control	-552.8	.048 *
	HIRE	Control	-1124.8	.001 *
	HIAE	HIRE	572.0	.001 *
Uncontrolled Eating	HIAE	Control	-2.5	.201
	HIRE	Control	6.1	.003 *
	HIAE	HIRE	-8.7	.001 *

* Significant at p<.05
HIAE = High Intensity Aerobic Exercise
HIRE = High Intensity Resistance Exercise

4. DISCUSSION

The results revealed that there is a significant difference between groups in dietary intake (DI). The reduction of energy intake can be observed following HIAE and HIRE compare to control group. This finding is been supported by previous research which stated that, acute high intensity exercise elicits physiologic responses of appetite hormones, such as the immune and stress system that account for post-exercise appetite suppression (Hunschede et al., 2017). Besides that, acute high intensity exercise does not increase hunger, the desire to eat (King et al., 2012) because the appetite and energy intake responses to exercise interventions delineate the appetitive change in exercise-induce weight management (Dorling et al., 2018). Physiologically, increased amount of PYY hormone secreted in the body, increase the suppression of appetite. Other study that supported the findings is done by Martin et al., 2007). In his study, 1 hours cycling at 65% of maximal HR (aerobic exercise) significantly increased plasma levels of the anorexigenic hormones PYY and GLP-1 resulted in a subsequent decrease in hunger. Other appetite hormones are involved in this action that changed the hormonal response of obese individuals which are ghrelin. Ghrelin are appetite hormone that secreted from endocrine cell in the stomach and other tissues cell. Acylation of ghrelin is essential for appetite regulation. According to Ueda et al. (2009), PYY, GLP-1 and ghrelin play roles in short-term regulation of appetite and energy homeostasis. Thus, from this finding the suppression of appetite after HIAE and HIRE caused by the change in acylated ghrelin response which decrease and PYY that increase.

TFEQ- 18 is the psychological response that has been used to measure eating behaviour of the obese individuals in this study. Uncontrolled eating is the only factor of TFEQ-18 that shows significant result between groups. Based on the result HIAE and HIRE have positive effect in controlling appetite compare to control group. Previous study also stated that acute exercise-induced energy deficits do not create an automatic drive to increase hunger (King et al., 2017). Next factor of TFEQ-R18 is cognitive restraint. Cognitive restraint referred to mind control over food intake in order to loosing or maintaining body weight. There is no significant difference between groups for cognitive restraint. This result is contradict with previous study. Researcher speculate that lack of motivation to lose weight among obese participants lead to such outcome. According to Martins et al. (2008), exercise effect is more effective in creating a negative energy balance in restrained eaters compared with unrestrained eaters; while unrestrained eater increases their energy intake after exercise, restrained eater tends to decrease their energy intake. So, the cognitive restraint of someone are depends on individual mind set or mind control not fully because of exercise itself. Emotional eating also has shown no significant difference between groups. The intensity of the exercise influences the emotional response perceived by the participants. According to (Hill et al., 2013) exercise at or above 60% of an individual's maximal oxygen

consumption (VO^2 max) generally produces a significant increase in circulating cortisol that has been related to stress response.

Other than that, exercise also helped to reduce glucose level in the body. Many studies showed an improvement of glucose level following exercise. In a study done by Rice (2000), aerobically trained individuals demonstrate decreased glucose level following exercise. In other studies, single exercise bout is associated with significant improvements in insulin sensitivity (Rice et al.,1999); and exercise training showing effect in glucose control in diabetic patients (Snowling et al., 2006). However, present study shows there is no significant difference of blood glucose level between groups following exercise interventions but there is significant increases from pre to post test for HIAE group. According to (Adams, 2013), during intense exercise (>80% VO2max), catecholamine levels rise markedly, causing glucose production to rise. When there is a physically or emotionally stressed, adrenal glands send catecholamines into blood that lead to production of heptic glucose from the process of gluconeogenesis. In the other words, infusing catecholamine is associated with enhanced rates of aerobic glycolysis (resulting in adenosine triphosphate production), glucose release (both from glycogenolysis and gluconeogenesis), and inhibit of insulin mediated glycogenesis (Barth et al., 2007).

5. CONCLUSION

In response to acute exercise, both HIAE and HIRE shows significant reduction of energy intake and improvement in appetite suppression. However, the effects of HIAE is superior compare to HIRE.

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