Effect of Acute Resistance Exercise on Appetite in Healthy Men

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Abstract: This study investigated the effects of acute resistance exercise on appetite markers ratings. Ten healthy male subjects participated voluntarily in the study and written informed consent was obtained from all subjects before participation. Subjects undertook two, 1,5 h trials (exercise and control) in a randomized crossover design. In the exercise trials subjects were performed three sets of 10 repetitions for each exercise (leg press, leg curl, chest press, lat pull down, shoulder press, biceps curl, sit–up) at 80% of 10RM and a 60-second rest interval between exercises and a 2-minute rest interval between sets were provided. In the control trial, subjects rested for 1,5 h. Ratings of subjective feelings of appetite markers were reported on 100 mm visual analogue scales (VAS) at baseline (-20) and at 0, 20, 40, 60 and 90 mins after baseline. Visual analogue scales (VAS) were used to measure the following appetite markers: (i) Hunger, (ii) Fullness, (iii) Desire to Eat and (iv) Prospective Food Consumption. Repeated-measures, two factor ANOVA was used to examine differences between the two trials over time for hunger change. Between-trial differences at each time point were examined using one-way ANOVA and Bonferroni post hoc tests when significant interactions were found. Two-way ANOVAs revealed significant ($P<0.05$) trial effects ($P<0.05$) and time ($P<0.05$) effects in all appetite markers except desire to eat marker. In conclusion, acute resistance exercise increases appetite in healthy men.

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1. Introduction

Energy balance is a metabolic condition that occurs when total energy expenditure is equal to energy intake, and under normal circumstances short and long term energy balance is very well regulated. However, imbalance between energy intake and expenditure observed in some people cause weight gain and inevitably obesity.

Obesity has become widespread around the world especially in developed and developing countries due to physical inactivity caused by recently increasing technological developments and increasing consumption of energy rich food (Przybylowicz et al. 2014; Gungor, 2014).

Exercise is a non-pharmacological method used in bariatrics and body weight control programs in order to increase energy expenditure with or without food limitations for years. Recently, it was reported that exercise can also change appetite and food intake besides increasing energy expenditure, which directed the interests of the researchers of the subject field to appetite-exercise relation and many studies have been conducted on this subject (Thivel et al. 2012).

Endurance exercises and resistance exercises are frequently used separately or together in weight control exercise programs (Garber et al. 2011). On the other hand, most of the researches on the effect of exercise on appetite are observed to test the effects of acute resistance and sprint interval type cycling and treadmill exercise protocols (cardiovascular) (Thivel et al. 2012; Deighton et al. 2013;Hagobian et al. 2013; Williams et al. 2013; Alkahtani et al. 2014; Desgorces et al. 2014; Martins et al. 2014). However, resistance exercises are perceived as the key component of exercise suggestions for weight control (Donnelly et al. 2009), and community health (Haskell et al. 2007; Nelson et al. 2007), and therefore determining the effect of resistance exercises on appetite is of utmost importance. There are few researches that examine the effect of resistance exercises (muscle strengthening) on appetite, and most of these are chronic studies (Guelfi et al. 2013). To the best of our knowledge, there are only two researches on the effect of acute resistance exercise on appetite and the findings of which are contradictory (Broom et al. 2009; Laan et al. 2010). Further researches with more controls on various experiment groups are required to reveal the effect of resistance exercises on appetite. Accordingly, the purpose of the study is to examine the effect of 60-minute acute resistance exercise on appetite.

2. Material and Methods

Subjects

Ten healthy male subjects participated voluntarily in the study and written informed consent was obtained from all subjects before participation. Subjects were excluded from participation in the study if they had a history of a chronic disease (e.g. cancer, heart disease, diabetes), uncontrolled hypertension or taking blood pressure medication, any condition that would alter one's metabolism (e.g. thyroid disease) or ability to exercise (e.g. orthopedic limitations), diagnosed psychological disorders (e.g. depression), recent weight loss of greater than 5 kg. or low levels of sleep (<6 h/night). The study was approved by the ethical board of the Abant İzzet Baysal University School of Medicine Clinical Laboratory Research, Bolu, TURKEY and it was performed in accordance with the principles of the Declaration of Helsinki. The characteristics of the subjects at baseline are shown in Table 1.

Anthropometric measurements

Height was measured to the nearest 0.1 cm using a Holtain fixed wall stadiometer. Body mass was measured to the nearest 0.01 kg using a beam balance. BMI was calculated as weight in kilograms divided by the square of height in meters.Percentage body fat was measured with the Tanita Body Composition Analyzer.All body weight measurements were obtained with subjects wearingshorts and a tee-shirt, without shoes.

Weight-lifting tests

A 10-repetition maximum test was completed for each of the 7 resistance exercises employed in the study. The order in which each exercise was performed was leg press, leg curl, chest press, lat pull down, shoulder press, biceps curl, sit–up. On a separate visit, subjects undertook a 60-min familiarization session in which they completed a full weight-lifting session: three sets of 10 repetitions of 7 different weight-lifting exercises at 80% of 10 repetitions maximum.

Exercise and Control Trials

Subjects undertook two, 1,5 h trials (exercise and control) in a randomized crossover design. In the exercise trials subjects were performed three sets of 10 repetitions for each exercise (leg press, leg curl, chest press, lat pull down, shoulder press, biceps curl, sit–up) at 80% of 10RM and a 60-second rest interval between exercises and a 2-minute rest interval between sets were provided. In the control trial, subjects rested for 1,5 h.

Appetite

Ratings of subjective feelings of appetite markers in response to rest and exercise forms were investigated using a randomized crossover design. Ratings of subjective feelings of appetite markers were reported on 100 mm visual analogue scales (VAS) at baseline (-20) and at 0, 20, 40, 60 and 90 mins after baseline. Visual analogue scales (VAS) were used to measure the following appetite markers: (i)*Hunger*, (ii) *Fullness*, (iii) *Desire to Eat* and (iv) *Prospective Food Consumption*.Specifically, participants were asked to provide subjective ratings of their current state for the following appetite markers: (i) *Hunger* – 'How hungry do you feel at this moment?' (ii) *Fullness* – 'How full does your stomach feel at this moment?' (iii) *Desire to Eat* – 'How strong is your desire to eat at this moment?' and (iv) *Prospective Food Consumption* – 'How much food do you think you could eat at this moment?'

Statistical Analysis

Paired sample t-test were used to assess differences between baseline values for each of these variables on the control and exercises trials. Repeated-measures, two factor ANOVA was used to examine differences between the two trials over time for hunger change. Between-trial differences at each time point were examined using one-way ANOVA and Bonferroni post hoc tests when significant interactions were found. Mauchley's test was conducted to examine sphericity for the repeated measures analyses. If the assumption of sphericity was violated, the Greenhouse-Geisser adjustment was used to protect against type I error. Statistical analysis was carried out using SPSS version 17.0 (SPSS, Inc., Chicago, IL, USA). Statistical significance was accepted at the 5% level.

3. Results

Table 1. Descriptive characteristics of subjects at baseline (mean±sd)

Age (yrs)	21.10±2.64
Height (cm)	176.20±5.00
Weight (kg)	70.31±7.19
BMI (kg/m^2)	22.66±2.30
Body fat (%)	12.72±4.42

Hunger

Baseline fasting hunger did not differ significantly (Paired sample t-test, P=0.292) between trials (control 29.76±21.61 mm, exercise 38.65±18.55 mm). Two-factor ANOVA revealed a main effect of trial (P = 0.021), a main effect of time (P= 0.000), and a trial and time interaction (P = 0.000) for hunger, indicating that responses differedover time between trials. Post hoc analysis indicated significant differences between exercise and control trial at 40, 60 and 90 min (P<0.05; Fig. 1).

Desire to Eat

Baseline desire to eat did not differ significantly (Paired sample t-test, P=0.170) between trials (control

28.21±17.96 mm, exercise 39.10±14.92 mm). Two-factor ANOVA revealed a main effect of time (P =0.000) for desire to eat, but there was no main effect of trial (P= 0.076) and no interaction (P= 0.862) effect (Fig. 2). These results indicate that desire to eat changed significantly during the trials but were not influenced by resistance exercise.

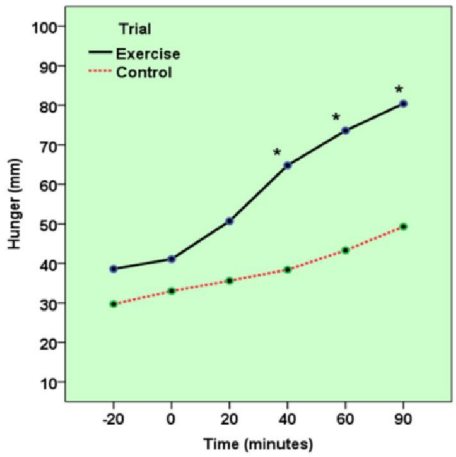

Figure 1. Hunger values over 90 min during the exercise and control trials. There was an effect of trial (P= 0.021),an effect of time (P= 0.000), and a trial x time interaction(P = 0.000) for hunger.*Significantly different from the control trial (P< 0.05) after Bonferroni adjustment.

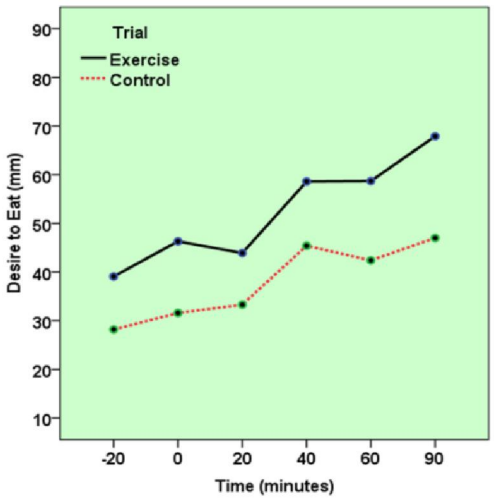

Figure 2. Desire to eat values over 90 min during the exercise and control trials. Two-factor ANOVA revealed a main effect of time (P =0.000) for desire to eat, but there was no main effect of trial and no interaction effect.

Fullness

Baseline fulness did not differ significantly (Paired sample t-test, P=0.090) between trials (66.42±19.01 mm, exercise 51.31±14.08 mm). Two-factor ANOVA revealed a main effect of trial (p= 0.032), a main effect of time (p= 0.001), and a trial and time interaction (p=0.047) for fullness, indicating that responses differedover time between trials. Post hoc analysis indicated significant differences between exercise and control trial at 60 and 90 min (P<0.05; Fig.3).

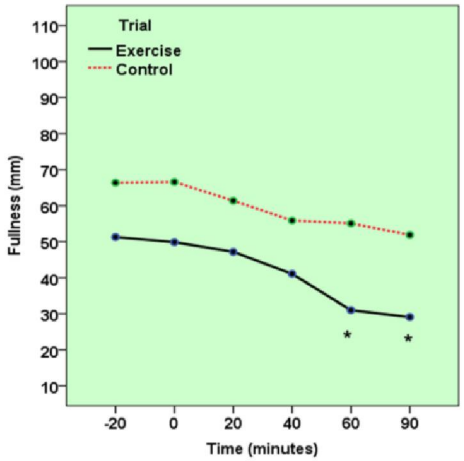

Figure 3. Fullness values over 90 min during the exercise and control trials. There was an effect of trial (P= 0.032), an effect of time (P= 0.001), and a trial x time interaction(P = 0.047) for fullness.*Significantly different from the control trial (P< 0.05) after Bonferroni adjustment.

Prospective Food Consumption

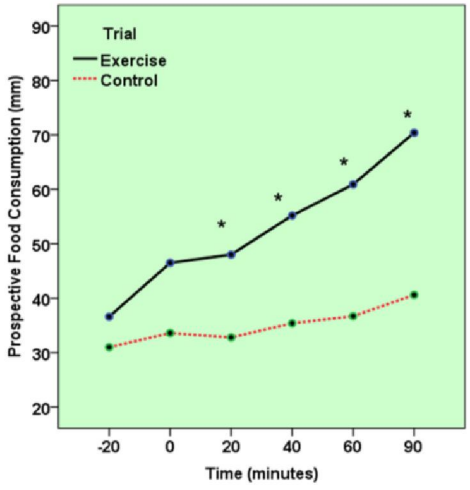

Figure 4. Prospective food consumption values over 90 min during the exercise and control trials. There was an effect of trial (P= 0,019),an effect of time (P= 0,000), and a trial x time interaction(P = 0.041) for prospective food consumption.*Significantly different from the control trial (P< 0.05) after Bonferroni adjustment.

Baseline prospective food consumption did not differ significantly (Paired sample t-test, P=0.366) between trials (31.01±16.86 mm, exercise 36.62±14.03 mm). Two-factor ANOVA revealed a main effect of trial (p= 0.019), a main effect of time (p= 0.000), and a trial and time interaction (p=0.041) for prospective food consumption, indicating that responses differedover time between trials. Post hoc analysis indicated significant differences between exercise and control trial at 20, 40, 60 and 90 min (P<0.05; Fig. 4).

4. Discussion

The aim of this study is to test the effects of acute resistance exercise on appetite markers ratings of healthy male individuals. The findings revealed that while the markers of hunger, fullness and prospective food consumption increased during and after 60-minute resistance exercise, there were no significant changes in the marker of desire to eat.

Recently many short and long term acute exercise studies have been conducted to determine the effects of acute exercise on appetite. However, the findings of these researches are contradictory. Some of the researchers found an increase in accordance with the findings of our study (Lofrano-Prado et al. 2012; Kawano et al. 2013; Alkahtani et al. 2014), while some others found a decrease (Bilski et al. 2013; Deighton et al. 2013) and some reported that there were no significant changes (Hagobian et al. 2013; Martins et al. 2014; Thivel et al. 2014). To the best of our knowledge, there have been only two researches on the effect of acute resistance exercise on appetite (Broom et al. 2009; Laan et al. 2010). In the study conducted by Broom et al. (2009), 11 healthy male individuals participated in 3 different 8-hour trials with one-week intervals. These are resistance (at 12 RM 80%, 10 different exercises 12 reps 3 sets and 3-minute rests between sets; a 90-minute of exercise in total), aerobic (60-minute treadmill exercise at 70% of Max. VO2), and control trial. The findings showed that, ratings of appetite markers decreased in both exercise trials during exercise, but increased after exercise. Aerobic exercise resulted in a greater suppression of hunger than resistance exercise. While the findings of our study related to the suppression of appetite during exercise contradicts with the findings of Broom et al. (2009), an increase in the appetite after the exercise supports our findings. Lean at al. (2010) conducted a similar research on nineteen young active adults involving separately conducted 35-minute aerobic and resistance exercises. On the contrary to the findings of our study, and Broom et al. (2009), Lean et al. (2010) found that hunger decreased only after aerobic exercise, and no significant changes were observed after resistance exercise. As can be seen above, the effects of acute exercise on appetite, either aerobic or resistance, are very contradictory.

The possible reasons for these contradictions can be methodological differences such as exercise intensity, exercise duration, exercise type, gender, participant selection etc. Even there are some contradictory findings (Alkahtani et al. 2014; Martins et al. 2014), appetite is observed to be affected especially by exercise intensity (Bilski et al. 2013; Deighton et al. 2013; Williams et al. 2013). When the studies focusing on this subject are examined, despite some contradictory studies, generally, it can be seen that low or moderate intensity exercises do not affect hunger and food intake or increases them (Blundell et al. 2003; Stensel, 2010; King, 2010; Rumbold et al. 2011; Ozen 2012; Bilski et al. 2013).Researches on the effect of high intensity exercises (>max.VO_2 %70) found that acute exercise suppresses hunger and energy intake (Blundell et al. 2003; King et al. 2011; Vatansever et al. 2011; Bilski et al. 2013). The possible cause for the suppression of hunger only after high intensity exercises is that, during high intensity exercise, sympathetic nervous system activation increases, blood flow in splanchnic area decreases and most of the blood in the circulation is directed to active muscles (Ikeda et al. 2010). In our study, we found that appetite was not suppressed but increased. The main reason for this may be the low exercise intensity. Different results may be observed within the studies conducted with high intensity exercises.

Thus, more further controlled studies examining the different exercise types and intensities are required within this subject. In conclusion, acute resistance exercise with moderate intensity increases appetite in healthy men.

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