

## Effects of different modes of training on ghrelin concentration in normal-weight middle-age women

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### Abstract

*Introduction:* Ghrelin is a gut-derived peptide that stimulates appetite and playing a key role in short-term energy homeostasis. There is a strong correlation between increases in circulating ghrelin with weight loss and changes in ghrelin are related to changes in energy availability, include food intake and exercise expenditure. Thus, the aim of the present study was to compare the effects of continuous and discontinuous training on ghrelin concentration of non-athlete, middle-age woman.

*Material & methods:* Forty five middle-aged, non-athlete women voluntarily participated in this study. Subjects were divided randomly to three groups including: continuous, discontinuous and control group (each group 15). One day before the beginning of training program, the blood sample were taken in fasting state .The two training groups

participated in sport activities for eight weeks, three times a week with 50-70 heart rate/min for duration 60-90 minutes .The training program of continuous group were performed in one session and the program of discontinuous group were performed in two sessions with same time and intensity. 24 hours following the end of the 8<sup>th</sup> week, all the measurements were performed similar to the pretest phase. The data was analyzed using one way analysis of variance.

*Results:* The fasting ghrelin concentration significantly increased in both exercise groups in compare with control group ( $P<0.001$ ). Weight, also, in discontinuous group was significantly decreased in compare with control following 8 weeks of exercise training ( $P<0.05$ ).

*Conclusions:* Regular exercise training was found to improve the serum ghrelin concentration and some components of body composition in non-athlete, middle-age women; thus, it seems that this type of training can be efficient, safe and inexpensive way in order to health care of middle aged women.

**Keywords:** Ghrelin, Modes of training, Middle-age women

## 1. Introduction

Ghrelin is a gastrointestinal peptide that secreted by distinct endocrine cells of the stomach called ghrelin cells (1). Ghrelin appear to play a key role in energy homeostasis, through the activates the ghrelin receptors in the arcuate nucleus in the hypothalamus (2).Also, as the only circulating peripheral hormone, ghrelin seem to be involved with regulation of appetite. The evidences indicated the role of ghrelin in the adjustment of optimal energy homeostasis (3). Ghrelin is increased in starvation and decreased in obesity. However, a negative energy balance, like a small meals or exercise, can cause rapid response at the concentration of ghrelin (4). Fasting concentrations of ghrelin are increased following weight loss after a low calorie diet (5) or combination of calorie restriction and exercise (6). Leidy et al. (2004) showed an elevated

fasting ghrelin concentration in normal-weight young women after a 3 month exercise training and diet program leading to weight loss (7).

Moderate intensity aerobic exercise of 45mins, 5d/wk was performed by Foster-Schubert et al for a period of 12 month in previously sedentary post-menopausal women. Ghrelin levels increased 18% in exercisers who lost more than 3kg and did not alter in the group without weight loss. They showed that the amount of increase in plasma ghrelin correlated significantly with the magnitude of decreases in total fat mass, BMI, body weight and waist circumference(8). Another study by Ravussin et al. (2001) indicated that 93 days of a cycling intervention, resulting in a 6% body weight loss, increased 26% fasting ghrelin concentration in young men (9). On the other hand, 12 weeks of exercise training also report no change in ghrelin concentration. An aerobic training program at 75-80% of heart rate maximum for 3 times per week, 60 minutes per session, in middle-aged obese or overweight men, had a significant decrease in body mass, but no any changes in fasting ghrelin concentration reported (10). An exercise training of 12 months in overweight and obese postmenopausal women, also, showed no change in fasting ghrelin concentration following exercise training. Although, a dietary restriction intervention, in this study, resulted in women that lost more than 10% of their starting body weight had an increase in ghrelin concentration of 10.7%, but those losing 5-10% of their starting body weight having only 4.2% increase in ghrelin concentration. The researcher concluded that greater amounts of weight loss were associated with greater increases in ghrelin concentrations (11).

Collectively, all of the abovementioned studies were done in either obese and middle-aged women (10), healthy, normal weight young women (7), postmenopausal overweight and obese women (11), or males (9) and these evidences indicated that ghrelin either increases or does not change following exercise training. Previous studies, also, have evaluated the effect of exercise training versus non-exercise control group, whereas our study sought to compare two different modes of exercise in non-obese middle-aged women, which appear to be a specific segment of the society which had yet to be investigated. Then, the main purpose of current study was to investigate and compares the effects of continuous *vs.* discontinuous training on fasting ghrelin concentration.

## 2. Materials & Methods

### *Participants*

To investigate the effect of exercise modes on ghrelin concentration and anthropometric parameters the experiments were performed in a pretest-posttest manner with three groups. Forty-five non-athlete women between ages of 45 and 60 years volunteered to participate in this study. Subjects had no overt CVD and none of them were taking diabetes or hypertension medication and were non-smoker.

### *Study design and exercise protocol*

After receiving information about exercise protocol and procedures, the subjects gave written informed consent, and were randomly to three groups including: continuous, discontinuous exercise and control. Training groups participated in exercise training for eight weeks, three times a week with 50-70 heart rate/min for 60-90 minutes. Each training session began with a light warm-up followed by light stretching routine. Continuous group performed one continuous cardiovascular steady-state training bout per day, while, the training program of discontinuous group were performed in two sessions with same time and intensity. The program of two exercise groups was aerobic rhythmic training. The control group was instructed not to change their daily patterns of physical activity during the study period.

### *Measurement of variables*

Blood tests were taken 24 hours before and after program intervention. Each subject was asked to maintain a 12 hour fasting period prior to the test to reduce the possibilities of dietary interferences. Body weight and height measurements were with wearing light clothing and shoes off to best estimate true height and weight values. Body mass index (BMI) was calculated by dividing the subject's body weight in kilograms into their height squared ( $\text{kg}/\text{m}^2$ ). Waist circumference was measured to the nearest 0.1cm using a plastic tape measure at the narrowest circumference of the torso.

Venous blood samples (10 ml) for total ghrelin measurement were taken twice, 24 hour before and after exercise training period, from subjects in sitting, resting position. Serum and plasma samples were stored frozen at

-80°C. The blood samples were collected according to the kit manufacturer's recommendations and using the Linco Research radioimmunoassay kit (St. Charles, MO) for analysis. The minimum detectable concentration of the assay sensitivity was 13 pg/ml. All samples from a given subject were included in the same assay.

### *Statistical analyses*

One way analysis of variance was used to test for differences between groups and if significant differences were observed, tukey's post hoc test was used in order to find what the possible sources of difference were. All statistical analysis was performed with SPSS software (version19) at the significant level of  $P < 0.05$ .

### **3. Results**

At baseline evaluation, no significant differences were observed between the study groups for any of the studied variables. Table one showed anthropometric characteristics of subjects. As shown in Table 1, weight in discontinuous group was significantly decreased in compare with the two other groups.

Table 1. characteristics of subjects before and after 8 weeks of training in three study groups

| Variable                 | Continuous |               | Discontinuous |               | Control   |               | P value |
|--------------------------|------------|---------------|---------------|---------------|-----------|---------------|---------|
|                          | Baseline   | After 8 weeks | Baseline      | After 8 weeks | Baseline  | After 8 weeks |         |
| Age (years)              | 50.3±7.9   | —             | 48.8±5.1      | —             | 52.5±3.3  | —             |         |
| Height (cm)              | 168.2±5.2  | —             | 176.1±7.6     | —             | 170.7±4.4 | —             |         |
| Weight (kg)              | 72.9±6.3   | 70.8±7.2      | 74.1±3.2      | 70.3±4.1      | 73.8±4.7  | 73.1±5.2      | 0.04*   |
| BMI (kg/m <sup>2</sup> ) | 24.7±2.1   | 24.1±3.7      | 25.8±3.6      | 24.5±3.8      | 25.6±2.4  | 25.5±2.1      | 0.41    |
| Waist Circu. (cm)        | 94.1±7.5   | 93.4±8.1      | 96.3±5.1      | 91.1±6.2      | 95.2±8.3  | 94.6±7.8      | 0.59    |

\* Significant differences  $P < 0.05$

As shown in the Table 2 and Figure 1, the mean of ghrelin in both exercise groups increased in compare with the control group ( $P < 0.05$ ).

Table 2. Fasting ghrelin concentration in groups before and after 8 weeks of training

| Variable        | Continuous |               | Discontinuous |               | Control   |               | P value |
|-----------------|------------|---------------|---------------|---------------|-----------|---------------|---------|
|                 | Baseline   | After 8 weeks | Baseline      | After 8 weeks | Baseline  | After 8 weeks |         |
| Ghrelin (pg/ml) | 77.66±6.43 | 80.6±6.97     | 76.07±7.99    | 86.26±5.31    | 74.2±8.07 | 73.4±7.48     | 0.001*  |

Values are means± SD.

\*significantly different between groups  $p \leq 0.05$

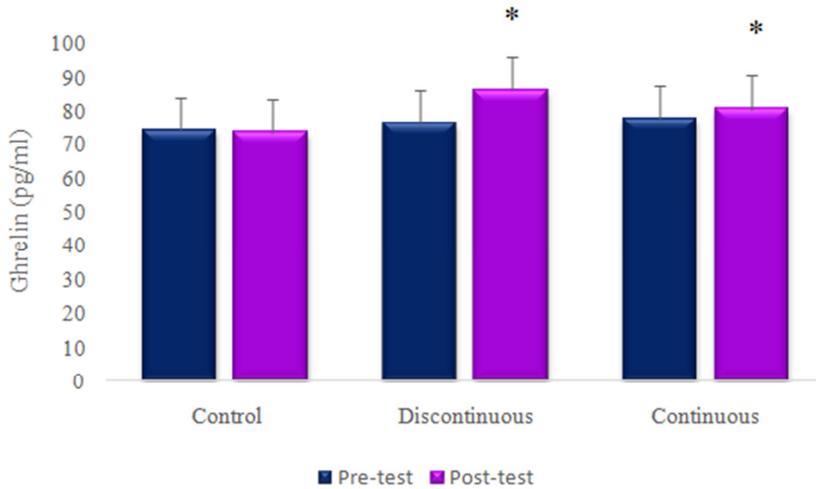


Figure 1. Baseline and post-exercise training fasting ghrelin concentration for each groups.

Values are means ± SD

\*significantly different between groups  $p \leq 0.05$

#### 4. Discussion

The purpose of this study was to determine the effect of exercise training modes on changes in ghrelin concentration in normal weight middle-aged women. We found that fasting ghrelin significantly increased in both exercise groups in compare with control group. Discontinuous group, also, shows decrease in weight compared with control group following 8 weeks of exercise training. Previous studies have evaluated the effects of exercise training on body composition and weight. Friedenreich et al in a study on 400 inactive women compared the effects of 150 minutes per week of moderate to intense exercise with 300 minutes per week (12). The results showed that high volume exercise

training (300 minutes per week) was more effective than moderate volume (150 minutes per week) in regards to reducing total body fat and other body composition parameters. There was a dose-response relationship for decreases in waist circumference measurements, waist to hip ratio and BMI. The results of another study indicate that losing weight through exercise alone resulted in a larger loss of fat mass and preservation of lean mass, as opposed to dietary restriction, which is an important consideration especially in older populations (13). In summary, studies indicated that weight loss and reduce in adiposity can be achieved by exercise training alone (especially aerobic training), and appears to be up to approximately 7%. The intensity, mode and duration of exercise play important roles in the amount of weight and fat loss.

The main finding of current study was the increase of ghrelin in the exercise groups compared to the control group. Several previous studies have investigated the response of ghrelin concentrations to exercise training; however the results of these studies are inconclusive (14-16). The effect of one bout of exercise on ghrelin concentration has been investigated, and most of those studies included a short exercise session of 20 minutes or less in young, healthy participants, resulted in no change in ghrelin concentration. A session of exercise over 30 minutes has, also, shown different results in increasing (17) and decreasing (18) ghrelin levels. Some studies have, also, shown that obese and normal weight individuals have a different ghrelin concentration response to exercise (16).

Some other studies have investigated the effect longer term of exercise training on ghrelin concentration and have shown that ghrelin levels either increases, or does not change. A short-term exercise training of running in young healthy males and females did not significant changes in the ghrelin compared to the control group (19). Twelve weeks of exercise training also did not change in ghrelin concentration in middle-aged overweight or obese men. The subjects completed 60 minutes per session of aerobic training at 75-80% of their heart rate maximum for 3 sessions per week. They had a significant decrease in body mass; however had no change in ghrelin concentration (10). In contrast, Foster-Schubert et al. (2005) showed a significant increase of plasma

ghrelin from the baseline after 12 months of aerobic exercise training in overweight, postmenopausal women (8). The aerobic exercise was 45 minutes and 5 days a week at 60-75% of their maximal heart rate. There was a small but significant weight loss of 1.4 kg. Mason et al. showed no change in fasting ghrelin concentration after 12 months exercise training in overweight and obese postmenopausal women (11). The exercise protocol was five days per week of moderate to intense aerobic exercise. Subjects who lost 5-10% of their starting body weight, exercise training resulted a non- significant increase of 2.2% in mean of ghrelin concentration.

In our study, also, the women in discontinuous group showed decrease in weight mass in compare with control group and the highest increase in the ghrelin concentration was seen in the same group. The inconsistent results are likely related to the different duration and intensity of the exercise, characteristics of the participants, and the length of training. Studies in this regards suggest that ghrelin may participate in a negative feedback loop regulating body weight. Plasma ghrelin levels have been shown to increase in response to weight loss resulting from hypocaloric diets, anorexia nervosa, cancer, cachexia and chronic failure of the kidneys, liver or heart (8). The possible role of ghrelin in the adaptive response to weight loss would be better supported if ghrelin levels were found to increase in the setting of weight loss that is not associated with decreased food intake, such as that resulting from chronic aerobic exercise. The mechanisms by which changes in body mass impact on circulating ghrelin are not fully understood while said the adiposity signals leptin and insulin to be important. Leptin that is produced within adipocytes have an inverse reciprocal relationship with ghrelin. Studies showed a direct inhibitory effect of leptin on the production of ghrelin (20). Alterations in circulating ghrelin in response to changes in body mass e.g. with weight loss or gain, may therefore occur secondary to changes in leptin. Insulin may also mediate some of the effects of adiposity on ghrelin (21). Specifically, it has been shown that insulin resistance and hyperinsulinemia are inversely associated with circulating levels of ghrelin (22) and this may represent one mechanism by which insulin is implicated in the homeostatic regulation of energy balance. One of the limitations of the current study was the lack of measurement of

leptin and insulin resistance due to financial constraints, which made us unable to show the relationships between these factors with ghrelin changes.

## 5. Conclusion

In conclusion, current study showed that fasting ghrelin concentration increased in normal weight middle-aged women who participated in two different mode of exercise training in compare with sedentary control group. These findings suggest that participate in any kind of physical activity may induce increase in ghrelin responses. However, whether this alteration is related with appetite and subsequent weight control needs further investigation.

**Conflict of interests:** None of the authors declare competing financial interests.

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