Journal of Physical Activity and Hormones
Vol 4, No. 3, Ser. 15 (September 2020), 049-060

The Effect of 12-weeks Selected Physical Exercise Alone or Combined with Omega-3 Supplement on Ghrelin and Leptin Levels in Young Non-Athlete Women

Eskandar Rahimi[1], Somayeh Saffari[2],
Sarah Hojjati3[3]*, Salman Vojdani[4], Mehdi Noura[5]

(1)*Associate professor in exercise physiology, Department of Physical Education and Sports Science, Zand Institute of Higher Education, Shiraz, Iran

(2) MS in exercise physiology, Department of Exercise Physiology, Marvdasht Branch, Islamic Azad University, Marvdasht, Iran

(3)*Assistant professor in exercise physiology, Department of Exercise Physiology, Shiraz Branch, Islamic Azad University, Shiraz, Iran. Email: sarah_hojjati@yahoo.com

(4) Assistant professor in pain management, Anesthesiology and Pain Department, Fasa University of Medical Sciences, Fasa, Iran

(5) Assistant professor in exercise physiology, Department of Exercise Physiology, Shiraz Branch, Islamic Azad University, Shiraz, Iran

Abstract

Introduction: Ghrelin and leptin hormones are engaged in energy regulation. The purpose of this study was to investigate the effect of physical exercise alone or combined with an omega-3 supplement on leptin and ghrelin secretion in healthy young women.

Material & Methods: In this experimental study, sixty non-athlete women (23.38±2.45) were randomly divided into control, exercise, supplement, and exercise-supplement groups. The exercise program consisted of 90-minutes basketball training (with 50-55% maximum heart rate (HRmax) increased gradually to 65-75% HRmax in two last weeks) for 12 weeks (3 days/week). The supplement was a daily intake of an omega 3 soft gel containing 1000 mg Omega 3. A blood sample obtained before and after the interventions assess serum levels of Ghrelin and Leptin hormones by ELISA. The one-way ANOVA and dependent T-test were used to analyze the data. $P \leq 0.05$ is considered statically significant.

Results: The serum level of leptin and ghrelin hormones significantly reduced and increased, respectively, in post-compared to the pre-experimental period in supplement, exercise, and exercise + supplement groups ($p<0.05$). Leptin hormone was reduced while ghrelin hormone increased significantly in supplement, exercise, and exercise + supplement groups ($p<0.05$) compared to the control group in the post-experimental period. There was also a remarkable difference between the supplement group and the exercise +supplement group ($p=0.05$).

Conclusion: Our results suggested that physical activity or omega 3 consumption alone leads to an increase in serum ghrelin hormone and a decrease in serum leptin hormone in young non-athlete women. It seems that a combination of both has synergic effects.

Keywords: Leptin, Ghrelin, non-athlete women, metabolic system, body weight

1. Introduction

Energy balance is under-affected in both leptin and ghrelin hormones. They are long-term regulation and fast-acting mediator hormones of energy balance, respectively. Leptin is engaged in suppressing food intake leading to weight loss and ghrelin contributes to meal initiation (1).

Leptin and ghrelin hormones are investigated in people with normal or overweight, healthy subjects or patients to find the mechanisms of energy balance. Leptin is and ghrelin hormones increase and decrease in obese patients, respectively. It is approved that obese patients are leptin-resistant too (1). Physical exercise as an energy balance mediator seems to have positive effects on ghrelin and leptin hormones. Regular resistance training is related to caloric restriction derived from appetite suppression. It leads to bodyweight increase and serum leptin level decrease in men compared to women (2). Serum ghrelin levels increased in both patients or healthy men, while leptin remained unchanged in male patients and decreased in healthy volunteers as a result of 8 weeks of aerobic exercise (3,4). It seems that, the pattern of decreasing leptin and lipid levels is matchable (4).

Long-chain omega-3 fatty acids are nutritional elements with the potential to modulate food intake (5). They may have a key role in balanced dietary intake during pregnancy and affect offspring development (6). In obese subjects, omega-3 supplement modulates postprandial satiety during weight loss (5), and may pose benefits in the prevention of weight regain following calorie restriction since it is associated with leptin levels increase (7). In non-obese people, omega-3 may decrease circulating levels of leptin (7). In patients with SCI, serum concentrations of leptin remained unchanged, and may influence the linear relationship between weight and leptin following 14 months' administration of docosahexaenoic acid and eicosapentaenoic acid (8). Although some researchers found positive effects of physical exercise and omega 3 on leptin and ghrelin hormones, however, the combination of them is not fully clear in healthy people. The purpose of this study is to investigate the effect of physical exercise alone or combined with an omega-3 supplement on leptin and ghrelin secretion in healthy young women.

2. Material & Methods

This experimental study was performed in Shiraz city in Iran. Sixty women (aged 23.38±2.45 years old) voluntarily participated and completed the consent form made by researchers including the details of experimental protocol and blood sampling.

The inclusion criteria were 18≤ age≤ 29, normal body mass index (BMI, kg/m^2), balanced diet (based on nutrition regime). The exclusion criteria were history of chronic disease, hypertension, any disorders or medication which induced metabolism alteration, psychological disorders, recent weight loss (9), irregular menstrual cycles, sleep deprivation (<7 h of sleep per night).

The women were randomly divided into four equal groups: control group received no treatment; exercise group underwent selected physical exercise (3days/week); supplement group received daily omega-3 supplement; supplement-exercise group underwent selected physical exercise (3days/week) together with daily omega-3 supplement. All interventions were performed over 12 weeks.

Supplement

Omega 3 supplement was an omega 3 soft gel (Viva omega-3 fish oil made in Canada) containing 1000 mg Omega 3, with 180 mg eicosapentaenoic acid (EPA) and 120 mg docosahexaenoic acid (DHA).

Selected Physical exercise program

The physical exercise program was a continuous basketball training performed 3 days/week for 12 weeks. Each session lasted 90 minutes which started with 15 min general warm-up including running (with 50-55% HRmax increased gradually to 65-75% HRmax in two last weeks), strength training, and a dynamic warm-up. The physical exercise program continued with a 15-minutes basketball-specific warm-up and continued with a 55-minutes basketball competition. The basketball competition is divided into 3 periods of 15 minutes each. There was a 5-minutes period of rest between sets. The Physical exercise program finished with 5-minutes of active rest. The intensity of training was checked based on the maximum heart rate computing by 220-age formula for each participant individually.

Blood sample

In the same condition, 12 hours fasting blood sample (10 ccs) was taken from all participants before and at the end of the interventions to assess serum levels of Ghrelin and Leptin hormones.

Anthropometric assessments

Bodyweight and height (Seca Stable Stadiometer Measurement 700, made in Germany), waist to hip ratio (measuring tape made in China) were measured in all participants. All measurements were performed in the morning with the same condition for all participants in the pre-exercise period.

Ghrelin and Leptin hormones assessments

ELISA method was used to measure serum levels of Ghrelin hormone using ghrelin kit (RayBiotech, united states) with the intra-assay CV $<10\%$, and the inter-assay CV $<15\%$, based on the manufacturer's specifications (10,11), and Leptin hormone using leptin kit (Mediagnost, made in Germany) with the Intra-/Inter-assay Variance $<15\%$ based on the manufacturer's specifications (12).

Statistical analysis

Normality distribution was assessed by Shapiro-Wilk test. All data reported in mean (SD). One-way ANOVA and dependent T-test were used to analyze the data. $P \leq 0.05$ is considered statically significant. All analysis was performed by SPSS software version 19.

3. Results

Anthropometric parameters of participants are presented in table 1. There was no significant difference among groups.

Table 1. Anthropometric parameters of participants.

	Age	Height (cm)	Body Weight	Body Mass Index

	(years)		(kg)	(BMI)
Control group	23.66±2.35	160.33±4.55	60.25±5.16	23.41±1.45
Exercise group	22.86±2.38	161.70±3.87	62.12±4.96	23.75±1.65
Supplement group	24.33±2.41	160.10±3.38	58.10±4.80	22.68±2.05
Exercise-Supplement group	22.66±2.52	162.42±2.67	61.33±4.90	23.26±2
One-way ANOVA	P=0.22	P=0.26	P=0.14	P=0.44
There was no significant difference among groups (p>0.05)				

There was no significant difference in body weight among groups in the pre-experimental period (Fig 1). In the post- experimental period, body weight reduced significantly in Exercise, supplement, and Exercise + supplement groups (Fig 1).

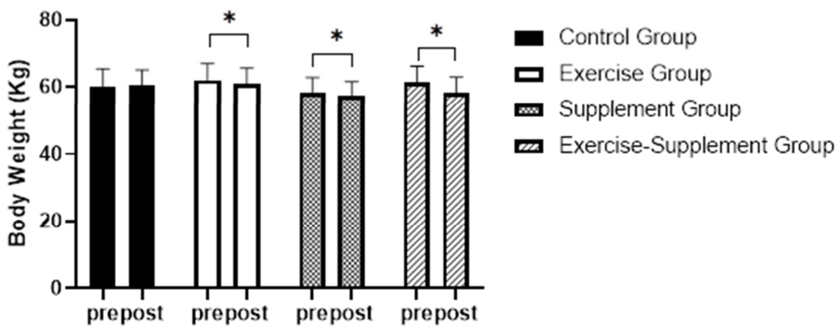

Fig 1. The mean(SD) of body weight (Kg) in control, supplement, Exercise, Exercise + supplement groups. * indicates significant differences at P< 0.05.

Plasma Level of Leptin Hormone

The plasma level of leptin hormone reduced significantly in the post-experimental period compared to the pre-experimental period in the supplement group (p=0.008), exercise group (p<0.001), and exercise + supplement group (p=0.015). There was no difference in pre-and post-experimental periods in the control group (p=0.14, Fig2).

One-way ANOVA indicated no significant differences among groups in serum level of leptin hormone in the pre-experimental period (p>0.05). However, there was a significant difference in the post-experimental period (p<0.0.05). Tukey post hoc test showed significant reductions in the supplement group (p<0.05), exercise group (p<0.05), and exercise +

supplement group ($p<0.05$) compared to the control group (Fig 2). We did not find any significant differences in the exercise group with the exercise +supplement group ($p>0.05$), and supplement group ($p>0.05$). There was no the difference between supplement group and the exercise +supplement group ($p>0.05$; Fig 2).

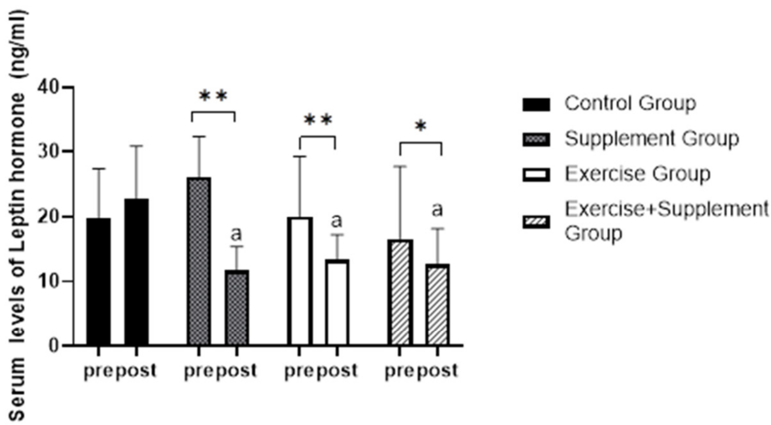

Fig 2. The mean(SD) serum level of leptin hormone in control, supplement, Exercise, Exercise + supplement groups. * indicates significant differences at $P<0.05$, ** indicates significant differences at $P<0.01$. a indicates significant differences with the control group in the post-experimental period at $P<0.001$.

Serum Level of Ghrelin Hormone

The serum level of ghrelin hormone increased significantly in the post-experimental period compared to the pre-experimental period in the supplement group ($p=0.01$), the exercise group ($p<0.001$), and the exercise + supplement group ($p<0.001$). There was no difference in the control group ($p=0.74$; Fig 3).

One-way ANOVA indicated no significant differences among groups in serum level of leptin hormone in the pre-experimental period ($p>0.05$). However, there was a significant difference among groups in the post-experimental period ($p<0.05$). Tukey post hoc test showed significant elevation in the supplement group ($p<0.05$), exercise group ($p<0.05$), and exercise + supplement group ($p<0.05$) compared to the control group (Fig 3). There was also a remarkable difference between the supplement group and the exercise +supplement group ($p<0.05$). We did not find any significant differences in the exercise group with the exercise +supplement group (p>0.05), and supplement group (p>0.05; Fig 3).

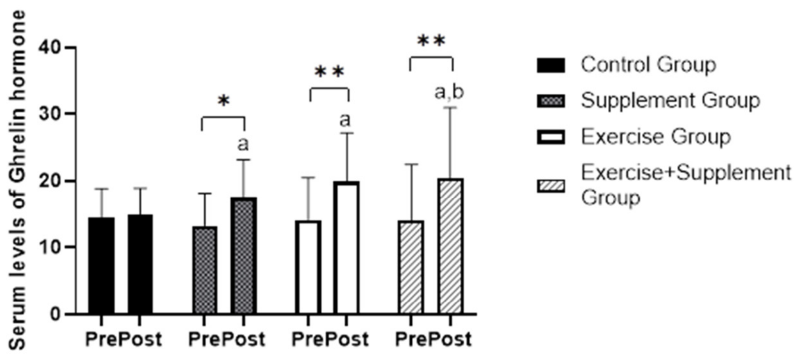

Fig 3. The mean(SD) serum level of ghrelin hormone in control, supplement, Exercise, Exercise + supplement groups. * indicates significant differences at P<0.05, ** indicates significant differences at P<0.01. a indicates significant differences with the control group in the post-experimental period at P<0.001. b indicates significant differences with supplement group in post-experimental period at P<0.05.

4. Discussion

This study indicated that 12 weeks of selected exercise alone or combined with omega3 consumption led to an increase in serum ghrelin levels and a decrease in leptin levels in non-athlete females.

Ghrelin and leptin hormones are greatly engaged in energy regulation and losing weight (13,14). Understanding both ghrelin and leptin functions will help us to control the metabolism process.

Recent researches in compromise with our results demonstrated that 14 weeks of anaerobic exercise and calories intake restriction to 1200–1800 kcal/d in two groups of 6 males and 6 female obese patients led to serum leptin level reduction (2). Also, 2 hours of basketball training for 8 weeks (5days/week) led to an elevation in serum ghrelin levels in adolescents (4). A review article supports our result regarding decreasing circulating levels of leptin after omega-3 consumption in healthy participants (7). a similar study on young women indicated that a period of the 90-minutes basketball training program (3days/week) together with omega3 consumption over 3 months led to increasing fat metabolism and is effective in adiponectin and leptin hormone secretion (14). 12-week jogged program (4 days/week; at 55% - 65% of maximal reserve heart rate) alone or combined with omega-3 (2 capsules/daily) led to enhance in ghrelin and appetite in non-athlete obese healthy women. While, serum ghrelin levels remained unchanged after taking omega-3 (13). The difference between our results with the mentioned article regarding ghrelin hormones in the supplement group is not due to the dose of omega-3 taking, because they used more does of omega-3 every day (2 capsules vs 1). And probably it is not due to participants ‘status. Although in the mentioned article, the participants were obese people and ours were healthy, however, another study on obese subjects (14) found the same results as ours. Therefore, the differences in ghrelin hormones responses to omega-3 in different studies are not very clear. Some studies showed no change in leptin levels in patients with colorectal cancer who participated in 8-weeks walking (45-min;50-60% of target heart rate; 3days/week) which was followed by 1 week detraining (3) or in patients with spinal cord injury who received daily two MorDHA® capsules (each capsule containing 465 mg of DHA and 63 mg of EPA) for 14 months (8).

The reasons for these uncompromised serum leptin levels may be due to different health statuses in participants. As in our study, the participants were healthy women. In studies on obese women as same results as ours were obtained. while, in studies on colorectal cancer or spinal cord injury patients, the serum leptin levels remained unchanged.

Exercise increases the cellular fuel demands by altering metabolic changes by disrupting cellular energy charges. Exercise activity leads to physiological stress. Therefore, it is a potential regulator of leptin secretion. Changes in the fuel flow, circulating hormone concentrations, and energy expenditure can affect serum leptin concentrations (14).

The results of this study probably support the idea that aerobic exercises may increase ghrelin levels and calorie intake due to elevated energy expenditure (13). According to the mentioned studies and present results on increasing ghrelin and decreasing leptin levels after 12-week selected exercise activity, it seems that physiological stress of long-term exercise activity triggers the response of metabolic hormones and decreases body weight. The energy deficit is probably exacerbated as a result of the influence of omega-3 on body fat metabolism, therefore, the human physiological system increases ghrelin levels and reduces the leptin levels secretion to maintain energy balance.

5. Conclusion

Physical activity or omega 3 consumption alone leads to an increase in serum ghrelin hormone and a decrease in serum leptin hormone in young non-athlete women. It seems that a combination of both can increase the effects.

6. Acknowledgments

We thank all participants who volunteer to participate in this study. We also appreciate Dr. Seyed Ahmad Tabaiyan for his effective advice in this research.

Conflict of interests:

The authors of this study have no conflict of interest.

References

1. Klok MD, Jakobsdottir S, Drent ML. The role of leptin and ghrelin in the regulation of food intake and body weight in humans: a review. Obesity reviews. 2007 Jan;8(1):21-34.

2. Elerian AE, Abdeen HA, Elmakaky A, Mostafa MS. Efficacy of gender, anaerobic exercise and low calorie diet on leptin, ghrelin hormones and hunger perception: A comparative study. Obesity Medicine. 2020 Jun 1;18:100213.

3. Nuri R, Moghaddasi M, Darvishi H, Izadpanah A. Effect of aerobic exercise on leptin and ghrelin in patients with colorectal cancer. Journal of cancer research and therapeutics. 2016 Jan 1;12(1):169.

4. Dundar A, Kocahan S, Sahin L. Associations of apelin, leptin, irisin, ghrelin, insulin, glucose levels, and lipid parameters with physical activity during eight weeks of regular exercise training. Archives of physiology and biochemistry. 2021 Jul 4;127(4):291-5.

5. Parra D, Ramel A, Bandarra N, Kiely M, Martínez JA, Thorsdottir I. A diet rich in long chain omega-3 fatty acids modulates satiety in overweight and obese volunteers during weight loss. Appetite. 2008 Nov 1;51(3):676-80.

6. Xavier S, Gili J, McGowan P, Younesi S, Wright PF, Walker DW, Spencer SJ, Sominsky L. High Maternal Omega-3 Supplementation Dysregulates Body Weight and Leptin in Newborn Male and Female Rats: Implications for Hypothalamic Developmental Programming. Nutrients. 2021 Jan;13(1):89.

7. Gray B, Steyn F, Davies PS, Vitetta L. Omega-3 fatty acids: a review of the effects on adiponectin and leptin and potential implications for obesity management. European journal of clinical nutrition. 2013 Dec;67(12):1234-42.

8. Sabour H, Norouzi Javidan A, Latifi S, Shidfar F, Heshmat R, Emami Razavi SH, Vafa MR, Larijani B. Omega-3 fatty acids' effect on leptin and adiponectin concentrations in patients with spinal cord injury: A double-blinded randomized clinical trial. The journal of spinal cord medicine. 2015 Sep 1;38(5):599-606.

9. Tiryaki-Sonmez G, Ozen S, Bugdayci G, Karli U, Ozen G, Cogalgil S, et al. Effect of exercise on appetite-regulating hormones in overweight women. Biology of sport. 2013 Jun;30(2):75.

10. RayBio ® Human Ghrelin EIA Kit Protocol (2013) RayBiotech, Inc; www.raybiotech.com

11. Ricken R, Bopp S, Schlattmann P, Himmerich H, Bschor T, Richter C, et al. Ghrelin serum concentrations are associated with treatment response during lithium augmentation of antidepressants. International Journal of Neuropsychopharmacology. 2017 Sep;20(9):692-7.

12. Blum WF, Juul A. Reference ranges of serum leptin, In: Leptin- the voice of adipose tissue, Blum WF et al. eds. Johann Ambrosius Verlag, Heidelberg, 1997. Mediognost® Human Leptin EIA Kit, Inc; https://mediagnost.de/en/leptin-human

13. Ebrahimpour S, Irandoust K. The Effects of aerobic exercise and omega-3 supplementation on serum ghrelin and appetite levels in obese women. Journal of Practical Studies of Biosciences in Sport. 2016 Aug 22;4(7):33-42

14. Piroozan F, Daryanoosh F, Jafari H, Sherafati Moghadam M. The Effect of 12-Week Exercise with Omega-3 Supplement Consumption on Serum Level Changes of Adiponectin, Leptin, and Insulin in Girls. Avicenna Journal of Clinical Medicine. 2015 Sep 15;22(2):129-36.