Physical Activity in Children
ISSN: 2783-5391

Original Article

The Effects of 12 Weeks of Spinning Exercises on Ghrelin Hormone Levels and Body Composition of Overweight Adolescents with the Moderator Role of Gender

Lida Moradi *

Assistant Professor, Department of Sport Physiology, North Tehran Branch, Islamic Azad University, Tehran, Iran

*Corresponding Author: Lida Moradi. Assistant Professor, Department of Sport Physiology, North Tehran Branch, Islamic Azad University, Tehran, Iran. Email: L_moradi@iau.tnb.ac.ir

Received: 27 November, 2024; **Revised:** 6 December, 2024; **Accepted:** 28 December, 2024; **Published**: 31 December, 2024.

Abstract

Introduction: The rising incidence of obesity among adolescents, coupled with the heightened risk of associated health issues, has prompted researchers to explore a range of weight loss exercises and the underlying mechanisms that contribute to their effectiveness.
Objective: The aim of the current research was to study the effect of 12 weeks of spinning training on ghrelin hormone levels and body composition of overweight teenagers, male and female.
Methods: The current research was semi-experimental. 28 teenage girls (mean age of 13.2 years) and 28 teenage boys (mean age of 14.5 years) with overweight were randomly divided into four groups: exercise-boy, exercise-girl, control-boy and control-girl. The percentage of fat and fat-free mass was measured using body composition measuring device model 3 made in South Korea and the level of ghrelin hormone was measured by ELISA method; The exercise groups performed Spinning exercises three times a week for 12 weeks. Analysis of covariance was used for data analysis.
Results: The results of 2-factor covariance analysis showed that spinning exercises led to a decrease in body fat percentage and an increase in ghrelin hormone, and the effectiveness of spinning exercises was significantly higher in girls than in boys.
Conclusion: Spinning exercises are useful for the body composition of overweight adolescents and it seems that the increase in the amount of ghrelin hormone plays an important role in the effect of this type of exercises, especially in girls. Spinning exercise can be utilized to facilitate weight loss and enhance body composition of adolescents.

Keywords: Ghrelin Hormone, Spinning Exercise, Body Composition, Fat Percentage, Overweight and Teenagers

How to Cite: Lida Moradi. The Effects of 12 Weeks of Spinning Exercises on Ghrelin Hormone Levels and Body Composition of Overweight Adolescents with the Moderator Role of Gender. Phys. Act. Child. 2024;1(2):86-91. doi: 10.22034/pach.2024.490994.1042

1. Introduction

Adolescence is recognized as a pivotal and significant stage in human development, characterized by substantial behavioral transformations that influence the nutritional status of individuals within this age group (1). The rise of technology has contributed to a decline in physical activity levels, with physical inactivity linked to obesity and overweight, which represent major health concerns. Globally, there are approximately 340 million adolescents and 39 million children classified as obese. The World Health Organization projects that 167 million children and adults will face various health issues in the near future as a result of obesity (2,3). The World Health Organization's report indicates that the obesity prevalence among girls aged 6 to 19 years is around 18%, while for boys in the same age range, it is approximately 19% (4). Research conducted in Iran has also revealed that the prevalence of overweight among boys and girls aged 6 to 16 years stands at 4.5% and 8.8%, respectively (5). Being overweight during adolescence is linked to a range of complications and health issues. Although preventable, obesity can lead to the early onset of chronic conditions such as type 2 diabetes, metabolic disorders, hypertension, and cardiovascular diseases (6,7).

Recent research indicates that engaging in regular physical activity serves as a significant, cost-effective, and accessible intervention for reducing body fat, inflammation, and the risk of heart diseases, ultimately aiding in the management of obesity-related conditions (8). Aerobic exercises have been shown to enhance cardiorespiratory fitness and diminish risk factors among adolescents (9). Achieving optimal body composition can be facilitated through physical activities; one such activity is Spinning, a modified form of stationary cycling that incorporates varied pedaling rhythms, mental focus, emotional engagement, and the use of specific music during workouts. This exercise modality is particularly popular and typically conducted in dim lighting, where participants ride together on specially designed stationary bikes, synchronizing their movements to the beat of loud music and the motivational guidance of an instructor. The primary objective of this program

is to enhance physical capabilities and promote weight loss through virtual cycling, which may occasionally involve video assistance to help participants manage fatigue. The intensity of Spinning sessions is influenced by several factors, including cadence, pedal stroke frequency, resistance settings, and the rider's posture (sitting or standing). Notably, the distinctions between Spinning and other forms of aerobic exercise can be attributed to variations in training positions, execution methods, gear pressure, gear speed, and wheel resistance, leading to a substantial energy expenditure during Spinning workouts (10,11).

Ghrelin is a peptide hormone composed of 28 amino acids, primarily synthesized in the acid-secreting region of the gastric fundus. It is recognized as an endogenous ligand for the receptor that stimulates growth hormone secretion. This hormone is a significant environmental factor influencing food intake and body weight regulation, and it is associated with obesity and overweight conditions (12). Ghrelin is unique as the only peripheral hormone that promotes hyperphagia; when administered as a drug, it enhances appetite. Additionally, ghrelin stimulates the secretion of growth hormone (13). The ligand interacts with ghrelin receptors (GPCRs) and growth hormone-secreting receptors, which consist of 366 amino acid residues. The primary function of this peptide is to coordinate gastric activity, with over 70% of circulating ghrelin originating from the stomach. Besides the stomach, other organs such as the pancreas, placenta, kidneys, pituitary gland, and intestines are also capable of secreting this hormone. Research indicates that both ghrelin and growth hormone levels rise during periods of starvation; ghrelin appears to activate the hypothalamus, subsequently triggering the release of growth hormone (14).

Research has indicated that plasma ghrelin levels fluctuate under various nutritional conditions and energy states. During physical activities, alterations in the energy status of liver cells and skeletal muscles are observed. For instance, in individuals with obesity, plasma ghrelin levels decrease following insulin administration, food consumption, and intake of sugary substances. Consequently, it is expected that plasma ghrelin levels diminish in conditions of positive energy balance and rise in situations of negative energy balance (15). Studies have demonstrated that prolonged exercise regimens lead to an increase in total ghrelin, with a more pronounced effect in overweight and obese individuals (16). Additionally, Kim et al. (17) found that a 12-week program of resistance and endurance training results in elevated levels of acylated ghrelin. Research has also revealed that a reduction in appetite may stem from irregular production and signaling of appetite-related peptides, including ghrelin. Notably, findings from Barivar et al. (18) and Garcia et al. (19) suggest the existence of gender differences in ghrelin responses, which may be linked to ghrelin's potential mediating role in female fertility; the appetite-stimulating effect of ghrelin in female rats could be significant for the maintenance of fertility.

It has been observed that stress-induced eating disorders in women may result from disrupted ghrelin transmission. The administration of ghrelin and related pharmacological agents could potentially serve as effective treatments for these disorders. Given the differences in how genders respond to ghrelin and its distinct functions in women, the researcher proposed an investigation into whether spinning exercises influence ghrelin hormone levels and body composition differently in overweight adolescent girls and boys. Research conducted by Wang et al. (20) indicated that spinning exercises are beneficial in preventing metabolic diseases by enhancing anti-inflammatory markers. Additionally, Dana et al. (11) demonstrated that spinning exercises contribute to weight reduction, decreased body fat percentage, lower BMI, and elevated ghrelin hormone levels. Furthermore, Mani et al. (21) found that a single session of acute exercise resulted in a temporary rise in acyl plasma ghrelin, with exercise-induced increases in plasma ghrelin positively correlating with endurance capacity. Studies involving children (22), adolescents and individuals who are obese or overweight (23,10,24) have also confirmed that exercise elevates plasma ghrelin levels. The current study aims to address the existing scientific gap by offering coaches and athletes more precise and comprehensive insights into the impact of spinning exercises on ghrelin composition and levels, particularly in relation to gender differences. This information is intended to facilitate the development of effective training methods for adolescents aimed at enhancing body composition. Therefore, this study aims to address the existing scientific gap, thereby providing coaches and athletes with more precise and comprehensive insights regarding the impact of training on body composition and ghrelin levels in relation to gender differences.

2. Methods

This research was conducted as a quasi-experimental study regarding its methodology and was applied in nature concerning its objectives. The statistical population comprised overweight adolescent boys and girls residing in Tehran, with an average age of 13.1±2.3 years for females and 14.5±1.3 years for males. Participants had a body mass index exceeding 25 kg/m^2 and did not have any underlying health conditions, such as diabetes or hypertension. A key exclusion criterion was the absence of interest in participating in the study. The sample size was determined using Gpower software version 3.1.9.7, which calculated a statistical power of 0.80, an alpha level of 0.05, and an effect size of 0.38, resulting in a total of 60 overweight adolescents, divided into four groups of 15 individuals each.

2.1. Measurement

Height was assessed utilizing a SECA height meter, while weight was recorded with a digital scale manufactured in China. The plasma ghrelin hormone level was evaluated through the Aliza method using a German kit from a medical vendor, and body composition was determined using a body composition device, model 2020, produced in Korea. These instruments demonstrated strong validity and reliability.

2.2. Instructions

Initially, during a briefing session, the objectives of the research, the potential applications of its findings, possible advantages and adverse effects, as well as the methodology and duration of the exercises were communicated to the adolescent participants.

Subsequently, among these students, those with a BMI exceeding 25 kg/m², who had a medical history free of illness, infection, or drug use, were purposefully selected and randomly assigned to research groups. In the pre-test phase, measurements of height, weight, and body composition were conducted using a body composition device, and the level of the ghrelin hormone was assessed prior to blood sampling. Following this, the exercise group engaged in spinning exercises for a duration of 12 weeks, with sessions lasting between 45 to 67 minutes each week, while the control group refrained from any exercise program. Finally, in the post-test phase, body composition and hormone levels were re-evaluated, with ghrelin levels measured once again.

2.3. Exercise Protocol

Spinning exercises involve pedaling to music, which was incorporated into the training regimen during the initial two weeks. During this period, participants maintained a heart rate within 50% of their maximum, with an incremental increase of 2 minutes in pedaling duration each week and a 5% increase every two weeks. As the training progressed, the intensity escalated, culminating in the final week where the duration reached 67 minutes and the heart rate increased to 75% of the maximum. All activities were conducted under the guidance of a trainer, ensuring that the heart rate remained between 50% and 85% of the reserve heart rate, corresponding to a range from light to very high intensity. The intensity of the exercises was tracked using heart rate measurements obtained from a Polar pacemaker (25).

2.4. Blood Sampling Protocol

Blood samples were collected during the pre-test phase one day prior to the commencement of the training program and again during the post-test phase, 24 hours following the conclusion of the final training session. In both instances, 10 cc of blood was drawn after a 12-hour fasting period, between 8 and 10 am, by a laboratory technician from the left arm while the participant was seated. The samples were immediately placed on ice at 4 °C and transported to the laboratory. Serum was isolated using a centrifuge operating at 3000 revolutions per minute for 20 minutes, and the plasma ghrelin hormone levels were assessed utilizing a German kit, with the intra-individual variation percentage recorded at less than 4.7%. Zhu et al., (26) Salar et al., 2024.

Table 1. Exercise Protocol.

Week	Training Period	Warm Up	Intensity	Cooling
1	45	5 min	50% heart rate	5 min
2	47	5 min	50% heart rate	5 min
3	49	5 min	55% heart rate	5 min
4	51	5 min	55% heart rate	5 min
5	53	5 min	60% heart rate	5 min
6	55	5 min	60% heart rate	5 min
7	57	5 min	65% heart rate	5 min
8	59	5 min	65% heart rate	5 min
9	61	5 min	70% heart rate	5 min
10	63	5 min	70% heart rate	5 min
11	65	5 min	75% heart rate	5 min
12	67	5 min	75% heart rate	5 min

2.5. Data Analysis

In this section, descriptive data analysis was conducted utilizing indicators such as the mean and standard deviation. In accordance with the statistical assumptions required for covariance analysis, this method was employed for data analysis at a significance level of 0.05 using SPSS software version 26.

3. Results

Table 1 presents the average and standard deviation of body mass index, fat percentage, and ghrelin levels for two research groups during both the pre-test and post-test phases.

Table 2. Body Mass Indices, Fat Percentage and Ghrelin Level.

	Girl				Boy			
Variable	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
BMI (kilograms per square meter)	26.0±1.89	24.0±4.75	26.1±9.3	27.1±3.3	26.1±9.05	24.1±9.09	25.0±8.88	26.0±6.99
Fat Percentage	35.2±7.07	32.1±1.6	38.2±2.6	37.2±5.7	33.1±4.5	31.1±9.7	32.1±9.3	33.1 ±2.5
Ghrelin (pg/ml)	207.27 ± 2.2	228.25±5.1	228.20±6.6	231.20±9.1	225.25±8.01	238.24±0.03	222.19±4.1	226.21±0.3

The statistical method of covariance analysis was employed to examine the data, taking into account the foundational assumptions associated with this approach. The findings from the two-way analysis of covariance (exercise x gender) presented in Table 2 indicate that spinning exercises significantly elevate the levels of the ghrelin hormone (η=2.58, p<0.001, F=78.1 (55, 1)), while also contributing to a reduction in body mass index (BMI) (η=0.79, p<0.001, F=212.4 (55, 1)) and body fat percentage (η=0.62, p<0.001, F=90.2 (55, 1)) among adolescents classified as overweight. Furthermore, the interaction effects revealed that girls experienced a more pronounced increase in ghrelin levels (η=2.12, p=0.007, F=7.86 (55, 1)) and a more significant decrease in BMI (p=0.023, η=0.09, F=5.45 (55, 1)) and body fat percentage (η=2.13, p=0.005, F=4.48 (55, 1)) compared to boys.

Table 3. Results of Two-Factor Covariance Analysis.

	Gender		Exercise		Interaction	
Variable	F	P-Value	F	P-Value	F	P-Value
BMI (kilograms per square meter)	7.94	0.007	212.4	<0.001	5.45	P=0.023
Fat percentage	10.8	0.002	90.21	<0.001	8.46	P=0.005
Ghrelin (pg/ml)	7.96	0.007	78.1	<0.001	7.86	P=0.007

4. Discussion

The findings of this study indicated that spinning exercises resulted in a reduction of body fat percentage and BMI, alongside an increase in ghrelin hormone levels among overweight adolescents, with a notably greater effectiveness observed in females compared to males. This outcome aligns with the research conducted by Khodadadi et al. (27), Belicha et al. (28), Chavariaz et al. (29), Yoon et al. (30), and Dana et al. (11). For instance, Chavariaz et al. (29) demonstrated in their review of spinning exercises that indoor cycling enhances body composition. Similarly, Kaya et al. (31) found that a six-week regimen of spinning exercises resulted in decreased BMI and body fat percentage among overweight women. Several key mechanisms can be identified to explain the results of the current study; it appears that aerobic exercise in individuals with excess weight contributes to improved mitochondrial metabolism, an increase in mitochondrial volume, the repair of damaged proteins, the synthesis of new proteins, enhanced capillary networks, and increased insulin sensitivity, all of which are fundamental to reducing body fat and consequently improving BMI (32). Furthermore, pedaling training elevates energy expenditure, thereby activating the AMPK signaling pathway, which promotes fat oxidation, leading to a decrease in both fat percentage and BMI. Essentially, exercise seems to expedite metabolic reactions and energy production processes within cells. Additionally, the group nature of pedaling exercises fosters participant motivation, which can enhance the effectiveness of the workouts over time (33).

The findings of this study indicated that spinning exercises resulted in an elevation of the ghrelin hormone among overweight adolescents. This outcome aligns with the findings of previous studies conducted by Oergi et al. (16), Yousefi Chermahini et al. (34), Mani et al. (21), Yu et al. (35), Kim et al. (17), and Dana et al. (11). For instance, Dana et al. (11) investigated the impact of a ten-week spinning training program on body composition and ghrelin hormone levels in overweight teenagers, revealing that such training contributed to weight reduction, decreased fat percentage, and elevated hormone levels in plasma. It is essential to note that the mechanisms by which weight loss induces an increase in ghrelin remain unclear. However, it appears that the anabolic effects of the hormone, along with insulin-like growth factor-1 and prolonged food intake, may lead to a positive energy balance. This, in turn, enhances ghrelin secretion to sustain energy homeostasis during periods of energy restriction, which raises blood glucose levels and suppresses insulin secretion, thereby stimulating the body's demand for rapid energy production and promoting fat metabolism (36). Furthermore, ghrelin is likely to influence growth hormone responses to exercise and recovery, while growth hormone also modulates ghrelin levels through negative feedback, impacting appetite and eating behaviors. Additionally, exercise influences caloric intake, energy expenditure homeostasis, and may generate signals for ghrelin-producing cells in the stomach, thereby affecting appetite and the regulation of growth hormone (37).

The findings of the present study indicate that spinning exercises have a more pronounced impact on fat percentage, BMI, and ghrelin hormone levels in teenage girls compared to boys. This observation aligns with the findings of Greenman et al. (38). Ghrelin levels are positively correlated with insulin sensitivity and negatively correlated with waist circumference, waist-to-hip ratio, and the HOMA-R index. Research involving men and women across various BMI categories and age groups has demonstrated that insulin resistance is not solely associated with ghrelin but also significantly influences ghrelin's response to glucose. Furthermore, women tend to exhibit higher ghrelin levels than men in both fasting and postprandial states (39). These results are also in agreement with the elevated levels of appetite-regulating hormones, such as leptin, found in women, as well as the higher concentrations of ghrelin-regulating hormones, including growth hormone and prolactin, in females compared to males (40).

4.1. Conclusion

The findings of the present study indicate that spinning exercises offer significant advantages for the body composition of overweight adolescents. Notably, the increase in ghrelin hormone levels appears to play a crucial role in the effectiveness of this exercise modality, particularly among girls. This is attributed to the higher concentrations of hormones such as ghrelin and leptin in females, which may enhance their capacity for weight and fat loss due to their elevated fat percentage. Additionally, girls may exhibit greater motivation compared to their male peers. However, the study is limited by the ambiguity surrounding the actual mental and physical exertion of the participants. Furthermore, the unique characteristics of this age group, which is marked by substantial hormonal and behavioral fluctuations, may have influenced the research outcomes. Consequently, it is recommended that future studies explore similar themes in both children and adults. Ultimately, the results of this research can be valuable for physical trainers and weight loss specialists in designing effective exercise programs.

Acknowledgments

The author is grateful to all participants who participated in this research.

Footnotes

Authors' Contribution: This study was carried out solely by the corresponding author.

Conflict of Interests: The researcher confirms that there is no conflict of interests in this study with any participant.

Data Availability: The data that support the findings of this study are openly available upon request from the corresponding author.

Ethical Approval: The author confirms that all steps and requirements of this study comply with ethical guidelines. Participants were informed about the characteristics of the study and gave written informed consent.

Funding/Support: This research received no external funding.

Informed Consent: Informed written consent was obtained from all participants.

Supplementary Information accompanies this paper at doi: 10.22034/pach.2024.490994.1042

ORCID iD

Lida Moradi https://orcid.org/0000-0002-4012-6199

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