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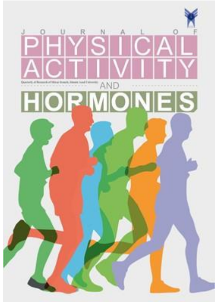

Effect of Eight Weeks of Combined aerobic-resistance Training on Sleep Quality, Prolactin Hormone, and Growth Hormone, of Overweight and obese adolescent girls

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Abstract

Introduction: This study aimed to determine the effect of eight weeks of combined aerobic resistance training on sleep quality, prolactin hormone, and growth hormone of overweight and obese adolescent girls.
Material & Methods: In this quasi-experimental study, 30 overweight and obese adolescent girls were randomly divided into two experimental groups of 15 people (age: 16.33 ± 0.97 years; body mass index: kg/m2) and control group (age: 16.53±1.18 years; body mass index: 30.48±3.26 kg/m2). The experimental group performed eight weeks of progressive aerobic resistance training, three sessions per week. Each session consists of 10 minutes of warming up, 5 minutes of cooling down, 30 minutes of aerobic exercise with an intensity of 60-80% of the maximum heart rate, and 45 minutes of resistance exercise with an intensity of 50-70% Repetition Maximum (1RM). Before and after eight weeks of training, sleep quality, anxiety level, prolactin, and growth hormones were measured. Statistical information was obtained by one-way ANCOVA and U-man-Whitney tests through SPSS software. A significance level of p<0.05 was considered.
Results: The results showed that eight weeks of aerobic-resistance training had a significant effect on improving sleep quality and anxiety (p=0.01) and had no significant effect on prolactin and growth hormone changes (p>0.05).
Conclusion: Combined aerobic resistance training probably improves the quality of sleep of overweight and obese students and does not affect prolactin and growth hormone levels.

1. Introduction

Obesity during childhood and adolescence remains one of the most important issues in global health. Over the past 4 decades, obesity in children of all ages has increased worldwide (1) The prevalence of obesity varies according to racial, ethnic, and socioeconomic factors (2) and increases with advancing age. Childhood obesity has been tracked into adulthood(3). There is an association between sleep duration and the risk of being overweight or obese in both children and adolescents (4). Adolescence is marked by dramatic changes in sleep; there is a high prevalence of insufficient and poor-quality sleep (5).

Sleep is a natural and reversible condition that is controlled primarily by neurobiological processes, and it is a physiological part of human life that is necessary for the maintenance of health and well-being. Sleep is associated with a reduction in the perception of external stimuli and the cessation of motor activity (6). The quality of sleep is influenced by many factors, such as diet, physical activity, and genetic and environmental factors(7). Recent scientific literature revealed a link between sleeping hours and metabolic effects that predispose to weight changes, also, an association between increased body mass index (BMI) and short sleeping hours(8). on the other hand Generalized Anxiety Disorder causes sleeping problems, and new research suggests sleep deprivation can cause an anxiety disorder(9). Research also suggests sleep disruption is present in nearly all psychiatric disorders. Moreover, people with chronic insomnia are at high risk of developing anxiety disorders Anxiety disorders are common mental health Conditions. The level of anxiousness people experience in anxiety disorders is over-proportionate to the situation, causing unpleasant emotions and/or physical changes, like disruption of blood pressure level and gastrointestinal distress(10) (11).

On the other hand Growth hormone (GH) is key hormone involved in the pathogenesis of obesity. Obesity is associated with blunted GH secretion, which is speculated to play a role for the development of obesity due to reduced lipolysis.GH is produced by the pituitary gland; it promotes cell division and protein synthesis for body growth and development. GH is regulated by a complex feedback system involving the pituitary gland, the hypothalamus, and other organs during deep sleep(12). GH is secreted in a pulsatile manner; GH release is inhibited by somatostatin and stimulated by growth hormone releasing hormone (GHRH)(13). In addition, GH secretion may be impacted by body fat distribution. Abdominal obesity and increased visceral fat have been associated with lower serum IGF-I concentrations decreased spontaneous 24-h GH release and diminished responses to pharmacological stimuli (14). Therefore, differences in body fat distribution may alter the GH response to exercise. Obesity also attenuates spontaneous GH secretion as well as the GH response too (15). One of the most potent stimulators of pulsatile GH release is exercise (48). Exercise has been shown to modify the activity and molecular character of GH variants in circulation (21). However, much remains unknown about the biological action of these GH variants.

Identifying factors that promote adipose tissue fitness may be of therapeutic value against insulin resistance and its associated metabolic diseases. We suggest that one such factor is the hormone prolactin (PRL). The hormone prolactin is principally secreted by the lactotroph cells of the anterior pituitary gland; however, it is also secreted from the breast, the decidua, adipose tissue, and parts of the central nervous system as well as some components of the immune system. It serves as a multifunctional hormone and numerous tissues within humans express prolactin receptors. To that end, the release of the hormone and its physiological functions are connected to emotional and physical stress response(16)

Circulating prolactin levels increase in the blood during exercise, with the magnitude of the increase approximately proportional to the intensity of the physical activity. Whether there is a specific intensity threshold required to induce a hormonal response is unclear, but most exercise above the anaerobic threshold initiates substantial and rapid prolactin elevations(17). Notably, prolactin has an underlying role in stress response regulation and stress adaptation (18). This is particularly relevant since maladaptation of the stress response is one of the major hypotheses for the development of major depressive disorder (MDD) (19), and stress is also related to an increased risk of health disorders relevant to Common Mental Disorders(CMD) morbidity (20). Higher prolactin has also been associated with the risk of developing psychosis (21), and with specific psychological symptoms of anxiety, hostility, somatization. These symptoms often occur in MDD, and are themselves associated with hypertension (22), and increased overall risk of CVD and metabolic syndrome (23)

Physical exercise training effectively ameliorates anxiety disorders(24) In the general population, it has been shown to positively affect neurogenesis in crucial areas of the brain, including the hippocampus, and positively correlate with mental health in children, adults, and older adults. Additionally, exercise has many positive effects on brain health and cognitive function(25).However, there is relatively little data available on the impact of physical activity on adolescents and youths with mental disorders(26).These findings suggest that the relationship between growth hormone and psychological well-being is complex and may depend on the specific condition and level of hormone secretion.

Despite the lack of studies evaluating GH and prolactin responses to stress, particularly to stimulation tests that are not dependent on exercise performance (which could confound the actual origin of the impairment, as described above), the current findings show that GH and prolactin tend to disclose blunted responses to stimulation tests. However, from an endocrinology perspective, it is unclear the exact underlying reasons that would induce the lack of proper response to anxiety(27).

Furthermore, in adults, GH levels increase during exercise (28), but the function and physiological effects of this hormone, especially in children and adolescents, are not fully understood. Growing individuals may exhibit different or excessive GH response patterns during exercise (29). Surprisingly, few studies have studied plasma GH response in children and adolescents during intensive exercise. Marin et al(30)reported that the GH response to exercise significantly increased with increasing puberty stage. Pomerants et al. (31) reported the rise of serum GH concentration was highest in the group with Tanner stage III during 30 min aerobic exercise. Exercise is promoted as an appropriate and effective approach to increase GH-mediated energy expenditure to prevent the development of obesity(32). The combination of endurance training (ET) and strength training (ST) in the same training session, so-called concurrent training (CT), is an effective strategy to improve both cardiorespiratory and neuromuscular functions, as well to induce a high-energy expenditure (33).

Research shows that physical activity can improve sleep quality. It did not have a significant effect (23). Also, in studies related to sleep, the research showed a significant effect of physical activity on growth hormone and prolactin, which is the highest at night (17, 25, 26) with It is observed that the amount of prolactin protein and growth in response to sports activities is dependent on its intensity and duration (24), and other studies showed that the body for the amount of growth hormone and prolactin before and after it did not have a significant effect (26, 27). Considering the conflicting findings and despite the fact that despite the research that sports and physical activity increase developmental complications, less research has been done in adolescence (24). So, this study aimed to determine the effect of eight weeks of combined aerobic resistance training on sleep quality, prolactin hormone, and growth hormone of overweight and obese adolescent girls.

2. Materials and methods

The research design was with two groups and in the form of a pre-test and a post-test. The samples of this research included overweight and obese adolescent girls aged 15-18 who were enrolled in the study from a selected school in Rasht city. All the students of Samiya Rasht selected school, which were 407 students, were selected as available. First, by calculating the body mass index of the girls they were identified as overweight and obese.

After calculating BMI, 80 overweight and obese students of School were given the DASS21 anxiety questionnaire. 43 of them had mild to moderate anxiety (those with severe anxiety were excluded), that 30 of them volunteered entered the study and were randomly divided into two equal experimental and control groups. These people did not have a specific disease and did not have minimal physical activity according to the definition of the World Health Organization(less than 150 min per week) or a combination of moderate and intense physical activity with different ratios. Sample were excluded from the study if they did not participate in 3 alternating sessions in the program. That this did not happen.

48 hours before and after the eight week exercise training program, blood samples were taken from the samples.

2.1. Exercise training program

The exercise training program of the experimental group includes training for 90 minutes (10 min warm up, 5 min cooling down, 30 min aerobic training with 60-80% of the maximum heart rate, 45 min resistance training with 50-70% of one maximum repetition.

Progressive aerobic exercise: Including 30 minutes of aerobic exercise with an intensity of 60-80% of the maximum heart rate, which was calculated using the formula of the maximum heart rate (220-age).

Progressive resistance training: including chest press, rowing, lunge, hamstrings, lat pull, front arm, and leg press, squat of large muscles of the upper and lower body. There was a 90-second rest between each 3 set. To obtain a maximum repetition by recording the amount of weight and the number of repetitions in the Brzycki Equation (Weight ÷ (1.0278 - (0.0278 × Number of repetitions)), the maximum strength of the subject in each movement Obtained.

Table 1. *Exercise training program*

	Strength training				Endurance training	
week	set	Repeat	Intensity	minute	minute	Intensity
1-2	3	8-10	(50-55%)1RM	45	30	60-65%
3-4	3	8-10	(55-60%)1RM	45	30	65-70%
5-6-7	3	8-10	(60-65%)1RM	45	30	70-75%
7-8	3	8-10	(65-70%)1RM	45	30	75-80%

2.2. The Pittsburgh Sleep Quality Index (PSQI)

The Pittsburgh Sleep Quality Index (PSQI) is a self-rated questionnaire which assesses sleep quality and disturbances over a 1- month time interval. Nineteen individual items generate seven “component” scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The scores of these questions were dichotomized into the seven main components, with a range of 0 to 3 per each component, and a maximum score of 21 and a minimum of 0 for the whole questionnaire. A total score of <5 indicates good overall sleep quality whereas a total score ≥ of 5 indicates poor sleep quality.

2.3. The depression, anxiety and stress questionnaire (DASS-21)

The depression, anxiety and stress questionnaire (DASS-21) consists of 21 questions developed by Lovibond et al. (1995). A set of three self-report scales was used for measuring negative emotional mood in depression, anxiety and stress. The above instrument is scored based on the four-point Likert scale from 1 to 4. Eventually, score 1 shows the minimum score and score 84 shows maximum level (21).The reliability and validity of the scales (DASS-21) were examined by Samani and Jokar (2007) in Iran (34).

3. Results

Results of descriptive analysis (n=30) were presented in Table 1 and 2. The Shpiro-wilk test indicated normal distribution for all of variables.

Table 2. *ANCOVA results for prolactin, GH, and anxiety in experimental and control groups (n=15 in each group)*

Index	Groups	Mean±SD pre test	Mean±SD post test	F	P
Prolactin (ng/ml)	Experimental	10.77±4.57	10.91±3.72	0.34	0.56
	Control	12.11±4.20	12.12±3.47		
GH (ng/ml)	Experimental	2.35±1.96	3.41±3.27	2.81	0.11
	Control	2.22±2.24	2.34±2.17		
Anxiety	Experimental	10.66±1.98	6.33±0.81	271.1	0.03*
	Control	10.60±1.80	10.73±1.94		

: P<0/05

The statistical results showed that there was a significant difference in prolactin plasma level and GH in the pre-test, but there was no significant difference between the groups in the post-test. In other words Experimental had no effect on growth hormone and plasma prolactin level (P=0.11, P=0.56 respectively). The statistical results showed that there was no significant difference between the two groups in the pre-test. But the test results in the post-test showed a significant difference. So in the post test, the level of anxiety in the Experimental group decreased significantly (P=0.03).

Table 3. *ANCOVA results for sleep Pittsburg questioner in experimental and control groups (n=15 in each group)*

Index	Group	Mean±SD pre test	Mean±SD post test	F	P
Sleep latency	Experimental	2.80±1.65	1.40±1.35	3.52	0.07
	Control	2.66±1.75	2.53±1.59		
Sleep duration	Experimental	6.03±1.61	7.46±1.39	8.01	0.01*
	Control	5.80±1.51	6.23±1.47		
Habitual sleep efficiency	Experimental	85.97±7.37	89.54±8.33	6.04	0.02*
	Control	83.58±7.15	88.91±6.17		
Sleep disturbance	Experimental	8.60±3.83	6.66±5.60	0.01	0.96
	Control	9.66±3.39	9.33±3.63		
Use of sleeping medication	Experimental	0.13±0.51	0.01±0.01	1.97	0.17
	Control	0.13±0.51	0.26±0.70		
Daytime dysfunction	Experimental	1.86±1.84	1.66±1.54	0.76	0.36
	Control	1.80±1.74	2.06±1.75		
Global PSQI score	Experimental	7.00±3.14	4.33±2.02	17.99	0.01*
	Control	7.13±3.35	6.73±3.01		

***: P<0/05**

The difference in the subjective quality of sleep, the amount of sleep efficiency, the amount of daily functional disorders and the amount of sleep disorders in both control and experimental groups was not significant in the pre-test and post-test. In other words, exercise did not affect the mental quality of sleep. (P=0.07)

Considering that in the pre-test, there was a significant difference in the amount of delay in falling asleep, after removing the covariate factor in the post-test, the results became significant again. In other words, the delay in falling asleep decreased after 8 weeks of aerobic-resistance training (P=0.01).

Considering that the difference in sleep duration was significant in the pre-test, after removing the covariate factor in the post-test, the results became significant again. In other words, sleep time increased after 8 weeks of aerobic-resistance training (P=0.02).

Considering that the difference in sleep quality was significant in the pre-test, after removing the covariate factor in the post-test, the results became significant again. In other words, sleep quality improved after 8 weeks of aerobic-resistance training (P=0.01).

4. Discussion

The results of our research showed that eight weeks of combined training on indicators of mental quality of sleep, sleeping pills, sleep disorders, daily performance disorders, sleep efficiency, prolactin and growth hormones, a significant effect, but overall sleep quality, sleep duration, the delay in falling asleep of the subjects improved.

GH response to endurance exercise is regulated by GH-releasing hormone (GHRH) which is secreted from the hypothalamus and acts on somatotropin cells of the anterior pituitary (35).

GH may play a central role in the regulation of the utilization and storage of energy (36). Previous studies that examined the effects of endurance and anaerobic-type exercise on GH suggested that the exercise should be appropriate to cause a significant metabolic effect (above the lactic anaerobic threshold) to stimulate GH secretion (37). Socratis et al (38) and Yamaner et al (39) reported that GH concentration significantly increases after intensive exercise in boys. The results of a study showed that GH concentration did not increase after an acute Incremental exercise until 70% maximal oxygen consumption in 10-year-old children (29)

GH may play a central role in the regulation of the Previous .(۳۶) utilization and storage of energy

Eliakim et al. (40)showed that in response to a metabolically matched exercise input, the GH response to exercise was reduced in obese children and adolescents. It is possible that the blunted GH and catecholamine response to exercise leads to reduced carbohydrate and fat utilization during exercise We found that a graded intensive (٤١). exercise led to a significant increase in GH levels in .adolescent and youth

In a research, Nouri et al investigated the effect of endurance and combined training in 45 overweight 20-year-old female students. The results showed that the growth hormone in the combined training group had a significant increase compared to the other two groups (42). One of the reasons for the discrepancy in this research is the type and intensity of training and the age of the subjects. In a study by rafiei et al., who investigated the effect of simultaneous and resistance training on the growth hormone of 35 boys aged 9-11 years for 6 weeks, the amount of growth hormone increased significantly in the simultaneous group among the reasons for the disparity between this research and our research, we can mention the gender of the subjects and the type and intensity of the exercises(43). In another research, Draper et al investigated the effect of two types of endurance-resistance and resistance-endurance training on the growth hormone of 16 9-11-year-old girls, and finally, the amount of growth hormone in both groups was significantly higher than the control group. increased(44).

During prolonged sustained exercise, the prolactin response is proportional to the intensity at which the exercise is performed, and there is a plateau in the level observed. However, extending the duration of the exercise session can result in a graduate increase in the magnitude of the prolactin response. This change in prolactin with prolonged exercise seems strongly driven by the elevation in core temperature occurring with the exercise, as cooling an individual mitigates in part the response Remarkably, during the night after a day-time exercise session, there are reports of a two- to three-fold increase in the nocturnal levels of prolactin (45).

The physiological mechanism inducing the augmented nocturnal responses is unclear, but relative to exercise training several highly feasible possibilities exists. First, there is an enhanced glucocorticoid response with exercise activity which can stimulate prolactin release

Prolactin is unique in that it is under chronic dopaminergic inhibition at the pituitary, and subsequent removal of this inhibition allows levels to elevate in the circulation without a direct stimulating factor(46)

Although the exact mechanisms of regulation of prolactin-receptor expression during exercise remain to be determined, one possibility is that it is upregulated by prolactin itself. Evidence from animal studies supports this possibility(47). Elevations in prolactin upregulated prolactin-receptor expression by the target cells of liver, lung, brain, and hypothalamus.

Moreover, the effects of physical exercise on anxiety depend on several parameters of exercise training, including frequency, intensity, and types of exercise(26).

Impairments in sleep quality may be one mechanism by which obesity attenuates nocturnal GH secretion. For example, reductions in slow-wave (deep) sleep have been associated with reductions in nocturnal GH secretion(48).

One limitation of the present study is that due to incomplete dietary data, we were not able to analyze adequately the impact of changes in dietary intake on GH and PRL secretion

Obesity also attenuates spontaneous GH secretion as well as the GH response to exercise (49). Mechanistically the decrease in spontaneous 24-h GH secretion in obesity has been attributed to a decrease in pulsatile GH release and a shorter half-life of endogenous GH. Analogously, reduced exercise-induced GH release in obesity has been attributed to a reduction in the mass of GH secreted per burst (15). Many obesity-related physical adaptations resemble those recognized in GH-deficient adults, including reduced muscle mass and exercise capacity, increased body fat especially abdominal visceral fat (AVF), and increased cardio metabolic risk.

Physical activity plays an important role in the maintenance of good sleep quality. A sufficient amount of moderate- to high-intensity exercise can improve the quality of sleep and prevent insomnia(50).

Exercise is considered a non-pharmacological approach that can be used to increase the release of GH levels into the blood circulation (51). The study conducted by Gough, Castell, Gatti, & Godfrey (2016) showed that aerobic exercise in the form of running on a treadmill for 40 minutes at a pace 5% below the lactate threshold speed significantly increased serum GH levels(52).

Gupta et al investigated the relationship between sleep and physical activity in 55 girls aged 7 to 12, and finally physical activity improved the quality of sleep. Also, Soltani Shall et al.'s study (53)confirmed the effect of exercise on sleep quality in their study on college students.

Rojas Vega et al. (54)did not observe a difference in growth hormone levels after 24 weeks of resistance training. A number of studies were inconsistent with our research. In a study conducted by Ohara et al. (55) on boys aged 18 to 25, the effect of endurance and resistance training they measured sprinting on prolactin and growth hormones after 60 minutes of training, and the aforementioned hormones increased significantly after 60 minutes. Among the reasons for inconsistency with our research, we can mention the sex of the subjects and the intensity of the training.

In a research by rafiei et al., who investigated the effect of simultaneous and resistance training on the growth hormone of 35 9-11-year-old boys for 6 weeks, the amount of growth hormone increased significantly in the simultaneous group(43). In another study, Amirsasan et al. investigated the effect of two types of endurance-resistance and resistance-endurance training on the growth hormone of 9-11-year-old girls. Finally, the amount of growth hormone increased significantly in both groups compared to the control group(56)

The effect of exercise on the quality of sleep can be said that by increasing the physical ability and as a result the self-confidence of people, the exercise activity will promote and improve interpersonal relationships and will ultimately lead to psychological health. Exercise and physical activity leads to biological and biochemical changes and improves physical and mental health (53)and the effect of exercise on physical and mental health can lead to better sleep(57). For example, reducing the level of anxiety It can lead to the improvement of sleep quality (58). And according to the reduction of anxiety in our research, it can be said that the reduction of anxiety can be a factor for improving the quality of sleep in this research. It can also be said that exercise and physical activity lead to more tiredness of the person, which causes deep sleep, which can lead to improved sleep quality. Sports training can improve the quality of sleep by increasing energy consumption, endocrine secretion and temperature(59).

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Therefore, given the limited research in this area and conflicting results, further investigations are warranted.

5. Conclusion

The results of the present study showed that combined exercises (aerobic-resistance) reduce body mass, improve sleep quality in overweight and obese adolescent girls. And this increase probably depends on the intensity of the exercises and its type. In addition to improving the quality of their sleep, the participation of students in sports activities can prevent the occurrence of diseases related to obesity and the transfer of obesity from adolescence to adulthood. Weight gain and finally the subsequent diseases.

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Conflict of interests: The authors declare that they have no conflict of interest relating to the publication of this manuscript.

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