**ORIGINAL ARTICLE**

# Investigation of Iris, Leptin, Ghreline and Some Hormonal Responses of the Strength Training Program Applied to Handball Players

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## ABSTRACT

**Background**: The effects of exercise on physiological systems were an inevitable truth. Especially the relationship of exercise with the endocrine system was one of the important focuses of interest. Irisin, Seratonin, Melatonin, Leptin, Ghrelin and Apelin hormones, which become a ball of interest recently, were the subjects that researchers follow and work with great interest.
**Aim**: To determine the effect of strength training program applied to handball players on the Irisin, Seratonin, Melatonin, Leptin, Ghrelin and Apelin hormones.
**Method**: 24 healthy male handball players between the ages of 18-24 participated in the study. Participants were randomly divided into two groups (control and experimental). While handball training was applied to the first group (control) for 6 weeks, strength training was applied to the second group (experimental). The blood samples of the participants were taken on an empty stomach in the morning by experts in the appropriate laboratory environment before the training at rest, according to the pre-test and post-test model. In the analysis of the data, descriptive statistics (mean, standard deviation) and Shapiro Wilk test, kurtosis, steepness and histogram graph were taken into consideration to test the normality of the distribution before starting the analysis, and it was observed that the distribution was normal. In this context, Paired Samples t-test was used to reveal intra-group differences and the Independent samples t-test statistical techniques were used to reveal differences between groups. The level of significance was set at 0.05 and the analyses were made in the Windows SPSS 22 package program.
**Results**: It was observed that irisin, apelin and ghrelin levels increased in the experimental group of the strength training program applied with the obtained results, it did not change in the control group. It was determined that the serotonin level increased in both the strength training group and the control group. While it was observed that the leptin level decreased in the Strength group, it did not change in the control group, and it was understood that the melatonin level did not undergo any change in both the experimental and control groups.
**Conclusion:** As a result, it was concluded that the 6-week strength training protocol applied to athletes caused significant changes in irisin, apelin, ghrelin, serotonin, leptin levels of handball players, but did not show any change in melatonin levels.
**Keywords**: Leptin, Ghrelin, irisin, Strength and Handball

## INTRODUCTION

Some of the physiological changes associated with strenuous exercise and their relationship with athletic performance are well known. In several studies, various physiological responses were associated with cardio-respiratory, hormonal parameters[1].

Based on the beneficial principle of exercise, the world of science curiously investigates the organism-exercise relationship and the changes that exercise has brought about on the organism[2]. Endocrine system hormones constitute an important part of this researches. Endocrine system hormones constituted an important part of this researches. Some of them are irisin, leptin, ghrelin, melatonin, serotonin, and apelin, which have gained serious sympathy especially today.

Irisin is expressing as a myokine stimulated by the effect of exercise[3,4,5]. Irisin is discovered as a thermogenic protein that passes from FNDC5 protein's muscle cell to the blood as a hormone which is FNDC5 protein gets active after the increase in the level of PGC1 alpha expression in the muscle cell after exercise, and transforms white adipose tissue into brown adipose tissue, causing energy wastage[3,6]. Irisin is included in muscles as a myokine called fibronectin type III domain 5 (FNDC5), named after the proteolytic product of the FNDC5 protein, by protecting people from metabolic problems with regular exercise activities. [7]It is thought that different cytokines released from the muscle called myokines also mediate the effects of exercise on the systemic level. Myokines are believed to stimulate muscle growth and hypertrophy, increase fat oxidation, insulin sensitivity, and stimulate anti-inflammatory activity[8]. Bruce M. Spiegelman et al. Discovered in 2012 a fresh myokine [3,9], named Irisin, inspired by the Greek goddess Iris (the apostle), as the hormone that controls exercise-related improvements in glucose homeostasis. It has been found that irisin plays an important role in the transformation of intraperitoneal adipose tissue to brown, and thus an anti-obesity and anti-diabetic myokine responsibility have been attributed[10]. Ongoing research reveals that irisin can alter adipose tissue browning, muscle growth, and energy homeostasis[11]. Leptin, known as the satiety hormone, is a

peptide hormone similar to cytokines, Containing 167 amino acids, weighing 16kDA, which control food and weight gain, which means debilitating, and its name derived from the Greek word leptos[12],[13]. Leptin is a protein produced by the ob-gene encoded by the mRNA in the lipid cell[14,15,16], sending messages to the hypothalamus and brain for energy storage and nutrient intake and opening the way for the necessary processes[17,14]. Its main source is the abdominal area and subcutaneous adipose tissue. After it is transferred to the blood, it reaches the MSS by crossing the blood-brain border barrier via its receptors (Lep R). This acts as a catabolic factor in reducing the leptin hormone's food intake level and increasing energy expenditure and preventing weight gain[18] because there is a linear relationship between leptin levels and body fat. As the amount of body fat increases, the leptin level increases. The aim is to increase energy expenditure and achieve balance. Ghrelin, which is an antagonist of leptin and expressed as the hunger hormone, was first discovered by [19] in the stomachs of rats and humans. Ghrelin orexigenic; In other words, its appetite enhancing activation is regulated by neurons harbouring specific receptors in the hypothalamus, and ghrelin is a versatile regulator of metabolism [20,21]. Ghrelin receptors are found in hypothalamic neurons that regulate food intake and satiety, as well as[22] they can be found in neurons in non-hypothalamic brain regions that contribute to eating behavior[23]. It regulates the energy balance in the short term by inducing appetite. In the long term, it causes an increase in body weight and fat. The ghrelin, which is responsible for controlling and regulating stomach movements, tightens the stomach walls and brings them closer to each other, especially when the stomach is empty. However, when the food consumed reaches our intestines, the level of ghrelin starts to decrease. Therefore, it can be said that preferred food quality and exercise may cause differentiation in ghrelin and leptin levels. Of course, these are not the only factors that affect ghrelin/leptin levels. Environmental factors such as stress, depression, anxiety[24], irregular and insufficient sleep, cold weather conditions will cause changes in the energy balance of the organism and the levels will be affected because more glucose is consumed. If there is an energy need or deficit in the environment, the level of ghrelin increases. It can be said that the energy deficit and need that occur especially during and after exercise will make changes in the level of ghrelin. In the opposite case, which is meeting the energy or the initiation of this process causes an increase in leptin level. Complications experienced in this situation may result in excessive weight gain.

Inactivity causes many health problems. One of these problems can affect us mentally and psychologically. Another hormone popularly known as the happiness hormone is serotonin. Serotonin is a monoamine [26,27] hormone known as 5-hydroxytryptamine (5 HT) and acting as a neurotransmitter within the nerve cells and being spread in nerve cells[27]. It is stated that low serotonin will cause the emergence of many diseases such as disturbing stomach syndromes, vomiting, eating disorders, hypertension, pulmonary hypertension, migraine, panic, anxiety, being schizophrenic, and depression. Also[26], It is saying that serotonin plays an important role in many physiological changes, including thermoregulation, regulation of the cardiovascular system, sleep-wake cycle, memory, aggression, and responses to emotions. Serotonin release is important to eliminate these adverse situations[28]. About the relationship of serotonin with exercise, it is stated that serotonin release and synthesis in the central nervous system and serum increase as a result of high-intensity exercises.[29] It is saying that physical activities performed cause serotonin release and increase. [30]It is stated in a conducted study that exercise causes changes in serotonin levels and these changes cause an increase in especially long-term exercise.

Apelin is another hormone thought to be an effect on exercise. Apelin appears as a new member identified for the adipose tissue family, isolated by [31] from bovine gastric juice. Apelin is an endogenous ligand of the G-protein coupled (APJ) receptor and demonstrates its effects by binding to APJ. Conducted studies show that apelin has a role in the cardiovascular functions[32], anterior pituitary functions, and regulation of fluid homeostasis[33], also plays a role in suppressing apoptosis[34] and acts as a coreceptor[35] in human immunodeficiency virus (HIV) infection. [36] It emphasized that apelin increases glucose utilization and inhibits insulin secretion. Studies have found different results in exercise programs applied at different paces. However, it is observed that there are increases in the level of apelin release generally in medium and low-intensity exercise programs[37].

In conclusion, it is stated that the arranging of the melatonin hormone's endocrine system plays a part in physiological functions such as; the strengthening of the immunity, smooth muscle's tonicity, and the blunting of gonadal functions[38]. It is stated that the level of melatonin is increased with exercise (it is possible to see contrary opinions in the literature) and also that muscle damage ratio is lowered by decreasing the inflammation and oxidative stress effects with melatonin reinforcement before tough exercise. Also, it is stated that melatonin has a protective function on cardio-tissue damage caused by acute exercises[39].

This study aimed to reveal the effects of both exercise and strength training on the endocrine system by especially determining the effects of the strength schedules applied to handball players on hunger hormones.

## MATERIAL&METHOD

**Research Design and Participants:** The study was conducted according to the pre-test, post-test model.The sample of the study consisted of 24 volunteer male handball players, licensed from Adıyaman municipality, between the ages of 18-24, with a height mean of 1.78 cm and weight mean was 73.8. The study consisted of 2 groups: the control group that only trained handball, and the experimental group that was applied strength training in addition to the handball training. Two measurements were taken in the study, pre and post-test. No diet program was applied to the participants. The pre-tests of the participants were taken before starting the study, and the post-tests were taken at the end of 6 weeks. During the study, all participants were asked to continue their normal life and not to do extra physical activity during the exercise

protocol. Participants signed a volunteer participation certificate before starting their training.

**Applied Training Programs**

Table 1: Strength Training Program

| **Warm-up:** | **Alongwithrunningfor 10 minutes, dynamic stretching and stretching were performed.** | | |
|---|---|---|---|
| Sequence | Area | Movements | Repetitions |
| **1** | Chest | ChestPress | 15 |
| **2** | Back | LatPullDown | 15 |
| **3** | Forearm | DumbellCurl | 15 |
| **4** | BackArm | TricepsExtension | 15 |
| **5** | Shoulder | ShoulderPress | 15 |
| **6** | Leg | LegCurl | 15 |
| **7** | Leg | LegExtension | 15 |
| **8** | Abdomen | Incline Sit Ups | 15 |
| **9** | Abdomen | AbdominalCrunch | Maximal |
| **10** | Waist | Hyperextension | Maximal |

The weights that the athletes could do at most 15±1 repetition during the pre-test adaptation week were determined. In the training, sets were applied as 1 set in the first week, 2 sets in the 2nd week, and 3 sets from the 3rd week. The rest periods between sets were 1 minute, and rest periods between movements were 3 minutes. Post-movement stretching was applied to the exercised muscles. After the workout, a 5-minute cool-down walk and stretching were performed. At the end of 6 weeks, the weights that they could do 15 repetitions were updated. The movements with the number of repetitions indicated as "Maximal" movements performed with body weight, and the athletes made the highest number they could.

General and special dynamic warm-up stretches were performed for 15 minutes after each warm-up game. Active stretching movements were performed for 10 minutes at each cooling [40].

**Biochemical Analysis:** Athletes went to the central laboratory of Adıyaman University Faculty of Medicine on an empty stomach at 08.00-09.00 in the morning before and after the handball and strength training, which lasted 60 minutes 3 days a week for 6 weeks. After the blood samples were centrifuged at 4000 rpm[3] for 5 minutes in a suitable laboratory, serum samples were stored at -70 degrees until analysis. Irisin, Seratonin, Melatonin, Leptin, Ghrelin and Apelin analyses were tested by the ELISA method.

**Statistical analysis:** In the analysis of the data, descriptive statistics (mean, standard deviation) and Shapiro Wilk test, kurtosis, steepness and histogram graph were taken into consideration to test the normality of the distribution before starting the analysis, and it was observed that the distribution was normal. In this context, Paired Samples t-test was used to reveal intra-group differences and the Independent samples t-test statistical techniques were used to reveal differences between groups. The level of significance was set at 0.05 and analyses were performed using the SPSS 22 program for Windows.

Table 2: Handball Training Program

| **Monday** | **Wednesday** | **Friday** |
|---|---|---|
| **Subject**: Ballhandling + Dribbling<br>**Total Time**: 60 min | **Subject**: HandballPassing<br>**Total Time**: 60 min | **Subject:** Basic GoalShot<br>**Total Time:** 60 mins |
| Warmingup<br>Throwingand holding theballwith a match. Themotherthrowsandholdstheball in themiddle.<br>Themotherthrowsandholds a ballacross. FaintingballgameDribblingbetweenslaloms.<br>Dribblingbehindobstacles.<br>Dribblingaroundobstacles.<br>Dribblingthroughobstacles.<br>Sayingthenumbersshownbythecoachwhiledribbling. Coolingdown | Warmingup<br>Passing in a triangle form, Passercrossing in themiddle,<br>passingwhilerunning,<br>Circularpassingwiththedoubleball,<br>Passing in a Square form, passing on thewall<br>Cross passingwith a singleball in a square form, Passingwith a crossdoubleball in a rectangle,<br>Passingwith a singleball in a rectangular form, Passingbychangingdirectionwith a doubleball (Motherpassescontinuouslyandthenchangesposition), Passingwith a doubleballwithfivepeople<br>Coolingdown | Warmingup<br>GalopRunningwhilearm-circling, pullingthekneeupandforward, pullingtheheelstothehips, withsmalldiagonalglidingstepstofull-arena.<br>Crossedpassingwithdoublefeetverticaljumping, Passingbyjumpingfromone, twoandthreesteps, Passingbyjumpingfromthe 3-4 meterswallwithone-double-reverselegleaping 1-2 steps, shoots at varioustargets on thewall, Jumping shot while walking, Jumping to the height in twosteps,<br>Jumping shot with a 3-step rhythm while running<br>Jumping over the bench and shooting on target<br>Jumping from a high gymnastic mat into the spaces in the goal with different step rhythms<br>Jumping shots with different step rhythms overthedefender<br>Jumpingshotsfromthe pivot zone in oneortwosteps,<br>Coolingdown |

## RESULTS

Table 3: Comparison of Variables Within and Between Groups

| **Variables** | **Groups** | **Pre-test** | **Post-test** | **WithinGroups** | **BetweenGroups** | |
|---|---|---|---|---|---|---|
| | | **Mean±Sd** | **Mean±Sd** | **p** | **Pre-test (p)** | **Post-test(p)** |
| İrisin | Control | 9,20±2,29 | 9,37±2,29 | 0,056 | | |
| | Experimental | 9,62±2,40 | 11,54±1,71 | 0,005* | 0,607 | 0,002* |
| Serotonin | Control | 13,96±2,57 | 14,58±3,03 | 0,040* | | |
| | Experimental | 13,75±2,70 | 21,70±10,27 | 0,004* | 0,817 | 0,027* |
| | Control | 94,29±30,72 | 95,67±31,35 | 0,052 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Melatonin | Experimental | 96,77±34,26 | 93,87±49,90 | 0,862 | 0,826 | 0,670 |
| Leptin | Control | 3,73±2,64 | 3,68±2,53 | 0,602 | 0,845 | 0,017* |
| | Experimental | 3,92±2,89 | 2,03±1,76 | 0,055 | | |
| Ghrelin | Control | 1273,90±882,39 | 1278,22±877,68 | 0,124 | 0,947 | 0,000* |
| | Experimental | 1264,48±884,39 | 2632,67±1187,41 | 0,000* | | |
| Apelin | Control | 1506,21±447,35 | 1526,00±449,76 | 0,104 | 0,084 | 0,000* |
| | Experimental | 1495,84±448,08 | 2279,46±516,93 | 0,000* | | |

* Statistically significant difference, Sd: Standard Deviation, p: Significance level

When Table 3 was examined, while there was no difference between the pre-test values of the control and application groups (p> 0.05), it was determined that there were significant differences between the groups in all parameters except for melatonin in the post-test values (p <0.05). Moreover, when the differences within the group were evaluated, it was determined that there was only a significant difference in the serotonin value in the control group (p <0.05), and there was no difference in the melatonin and leptin values in the experimental group (p0.05), but there were statistically significant differences in the values of irisin, serotonin, ghrelin and apelin. (p <0.05). According to the results of the study, 6-week handball and strength training caused changes in irisin, apelin, ghrelin, serotonin, leptin levels of handball players. Especially weight training caused changes in the levels of iris, ghrelin serotonin and apelin. It was determined that there was no significant change in melatonin levels. This study has shown that handball training and strength training will show positive and meaningful responses to the endocrine system, and we can say that appetite will form a model for weight control. Besides, we think that the results of the study will contribute to the researches on the subject as literature.

**DISCUSSION**

The study aimed to examine the effects of strength training programs applied to handball players for 6 weeks on the endocrine system. The results of the study showed that as a result of the training, there was no significant increase in the pre and post-test values within the group in the irisin levels of the male handball players who only trained handball. However, this situation is in the opposite direction in the experimental group. In other words, in addition to handball training, a significant increase in irisin levels within the group was detected in the experimental group that used strength exercises. This increase in irisin levels was thought to be effective due to strength training applied in addition to handball training. In other words, when we look at the post-test results within the group, it was seen that the group that was applied strength training in addition to handball training received more mean scores, which was thought to be due to strength training applied in addition to handball training[41].

Training programs were applied for 8 weeksand 3 days a weektocontrol, aerobics, interval and resistance groups, which were formed with individuals who participated voluntarily and did not exercise regularly and between the ages of 19-24, and a significantincrease in irisin levels in allgroupsexceptthecontrolgroupwerefound. The change between these groups was aerobic, interval, and finally the resistance group, in order. The most important increase in irisin level occurred in thegroupdoingresistanceexercises[42]. In the experimental study conducted on rats, it was found that irisin levels of thecontrolgroupdid not increase, but the irisin levels of theexperimentalgroup (high-ranged-low continuous) increasedmore than the control group, and there was nosignificant difference between the experimental groups[43]. It was found that irisin levels increased after 12 weeks of resistancetraining in oldermaleadults. [44] Itwasstatedthat as a result of aerobic and anaerobic training applications applied to 24 referees and 20 sedentary, irisin levels increased regarding training. However, contrary to the opinion that different exercise protocols applied increased irisin levels, there were studies related that the selevels did not increase. Many studies reported that acute exercises did not cause changes in the level of the iris[45-48].

When leptin levels were examined, there was no significant difference in the leptin levels of the control group that only trained hand ball and the experimental group that did strength training in addition to hand ball training. However, whenthe post-test values of the groups were examined, a significant difference was observed and a significant decrease was found in the leptin levels of the experimental group[49]. 26 male soldiers were exercised 5 days a weekfor 3 weeks, and at thee nd of thestudy, it was observed that there were significant decreases in leptin levels. Duringthe 12 (3 days getting used to, 9 days competition) cycling competition with 11 cyclists and 4 triathletes, a situation assessment was made and it was seen that the leptin levels decreased as a result of the competition. In the same study, it was seen that leptin levels return to the previous level between 48-72 hours[51]. At theend of 36 weeks of resistance training, it was determined that there were decreases in leptin levels in rowers[52,53]. However, some studies found no significant change in leptin levels during acute exercises. When a general evaluation was made, it was possible to state tha twhile the change in serum leptin levelsdid not reveal a significant difference in an acute exercise, there was a significant decrease in long-termexercises.

When we examined the ghrelin levels in our study, while there was no significant difference in the pre-post-test values of the control group within the group, a significant difference was found in the experimental post-test mean scores within the group. At the same time, it was determined that there was a significant difference when the control group and the experimental group post-tests were compared, and the mean scores of the experimental group increased more, in other words, the ghrelin levels of the experimental group increased more. [54] In the study conducted on extremely obese male and female, walking activities were applied at the submaximal level and it was detected that the ghrelin levels increased after 12 weeks[55.]. The values of ghrelin between male and female were examined and it was observed that it was higher in female. Later, after the exercise programs applied to these

participants, it was determined that ghrelin levels increased in male with exercise[56].

In another study, ghrelin levels were monitored at 3, 7 and 11 weeks of weight training on 7 athletes, and ghrelin levels increased intensity. Moreover, [57] the study found that ghrelin levels increased after a 12-week circular training program in obese women. Studies were showing that exercise did not alter ghrelin levels as well as studies showing an increase in ghrelin levels[58].[59]. In the study, no change was observed in ghrelin levels as a result of the test performed with a submaximal bicycle ergometer for one hour at 33, 7, and 20 degrees room temperature. Participants who were later taken to rest were retested and found no effect on ghrelin levels in temperature difference. It was thought that these different results occurring in ghrelin levels may be affected by exercise protocols such as the duration, intensity, and frequency of exercise programs. Another important issue was that the active and passive conditions of the ghrelin hormone, which has an important role in the evaluation of hunger and satiety, and the hours of blood samples taken during the day could cause such differences to occur. Because we thought that ghrelin, which acts as an antagonist of leptin and in energy balance, will increase with exercise due to energy expenditure.

Moreover, when we look at our research results, there was no significant difference in apelin levels within the control group, but there was a significant increase in apelin levels for the experimental group. While there was a significant difference in the post-test values between the groups, the handball players in the practice group had the highest mean score in this difference. In other words, it was thought that strength training, in addition to handball training in the practice group, had an important effect on the increase of apelin values[60]. It was stated that swimming exercises performed on rats can regulate the apelin level and have positive effects[61]. In the exercise program applied to a group of 54 patients with Type-2 diabetes, it was observed that only female participants had an increase in apelin values. [62] Before starting 50, 200 and 400 m swimming activity and the last blood samples were taken from the swimmers, it was found that there was a significant increase in the apelin values in the middle and long distance swimming test in the blood serum samples taken. In another study[63], an increase in apelin level was observed after high intensity interval training, which was applied to 8 healthy male with an average age of 20 years. Some studies stated that when the Apelin hormone was associated with exercise, increases depending on exercise, as well as studies claiming the opposite[64].

With the anaerobic sprint test applied to 15 female athletes, blood apelin levels were measured before, after and 24 hours after exercise, and as a result of the study, it was found that there were decreases in apelin values. Moreover, [65] aerobic exercise activities were applied to 20 obese women 3 days a week for 8 weeks and the intensity of the exercise was increased from 50% to 70%. As a result of the study; It was found that there was a decrease in plasma apelin and insulin levels. In the light of this information, it could be said that apelin, which has an important role in activating glucose metabolism, exercise intensity and the differences in energy metabolism associated with this violence would be important in the secretion of apelin. In the serotonin levels we investigated in our study; It was observed that there was a significant significance in the serotonin values of the control group, where handball training was applied, and the strength training group, which was applied in addition to the handball training. This situation was encountered with an increase in the last test group. In other words, it was noteworthy that the strength training practice group applied in addition to handball training had higher average scores. Besides, in the last test we conducted between the groups, it was determined that there was an increase in significant levels of serotonin levels and this increase received the highest score in the post-test of the experimental group. Continuing regular and physical exercises for a long time could increase the serotonin level by increasing serotonin secretion and expression in the central nervous system or blood serum and relaxing the body. [66] In the study, it was observed that the serotonin level increased as a result of 12 weeks of pilates exercise applied to women 3 times a week. In previous studies, it was determined that 10 weeks of physical exercise on humans increased serotonin levels in patients with depression[67]. In another study, [68] it was found that serotonin levels increased as a result of an exercise program designed to travel 60 minutes a day and 20 meters per minute for 4-5 weeks. [69] Recently, it was determined that serotonin levels increased as a result of aerobic exercises performed on rats for 20 weeks and 3 times a week. [70] It was stated that long-term aerobic exercise with 16 elderly people, aerobic activities in human and animal experiments affected serotonin release and there were increases in serotonin levels. In this pathway illuminated by the literature, it was possible to say that serotonin was stimulated and its release increased, especially as a result of long-term physical activities. However, in some studies, it was stated that there were no increases in serotonin levels or changes as a result of the study. When the training programs of these studies were examined, it could be said that physical exercises applied for short periods did not change or increase serotonin levels. [71] The effects of aerobic and anaerobic applications on rat serotonin levels were examined after a one-week program and no change in serotonin levels was detected. [72] A step-aerobics, spinning, educational game program was applied to 25 people for 60 minutes, and blood samples were taken just before and after the program to see if there was a change in serotonin levels. Although a statistically significant result was not reached at the end of the study, there was an increase in the average scores of the step-aerobic and educational game groups, but a decrease was observed in the spinning group, although it was not statistically significant. When the melatonin levels of the study were examined, there was no significant difference between the groups in both groups as a result of the strength training applied in addition to the control and handball training.

When the literature was examined, it was possible to encounter opposite results regarding melatonin level and change processes. It was stated that as a result of physical activity applied to children, after exercise in female, and 5 hours after the exercise applied to women melatonin levels was increased [73-75]. Similarly, [76] blood serum samples were

taken before and just after the climbing activity performed on 30 black men and it was found that melatonin values increased. Contrary to studies that said exercise increased melatonin levels, some studies stated that it did not change or decrease it. [77] It was stated that night exercises with high intensity suppressed melatonin release and caused sleep problems. In another study, [78] 10 healthy sedentary individuals with an average age of 22 were applied day and night acute exhaustion exercise, and no change in melatonin levels was observed at the end of the study. [79] The rats were given flotation exercises in the dark and light environment (15-30 minutes) at 00:30, and the melatonin content in the pineal gland of the group exercising in the dark decreased, but there was no change in the N-acetyltransferase (NAT) enzyme, which is important in the release of melatonin. It was possible to state that these different situations that occur in literature in general, in addition to the way of training, the time or dark-light environment at which it is applied will have a significant effect. In connection with the subject, [80] it was stated that the amount of melatonin synthesis and release would be significantly affected by light, and it was stated that melatonin levels in the blood serum were observed at night maximum and minimum levels during the day.

## CONCLUSION

According to the results of the study, 6-week handball + strength training caused changes in irisin, apelin, ghrelin, serotonin, leptin levels of handball players. It was determined that there was no significant change in melatonin levels. This study showed that strength training combined with handball training caused significant and significant differences in the endocrine system. In future studies, it could be said that researching different hormones and examining their psychological effects would provide a different benefit to the literature.

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