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THE EFFECT OF ENDURANCE TRAINING AND HIIT CARDIO ON ADIPONECTIN GENE EXPRESSION, SELECTED BIOCHEMICAL VARIABLES, AND BODY MASS INDEX IN REGULAR MALE FUTSAL PLAYERS AGED 45–55 YEARS

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Abstract:
The research problem focused on the challenges faced by regular futsal athletes aged 45–55 who suffer from weight gain and increased levels of fat and cholesterol. These issues were attributed to their engagement in certain types of physical activity following intermittent breaks from training, which failed to yield the desired results. Therefore, the aim of this study was to investigate the effect of endurance and HIIT cardio training on the gene expression of the hormone adiponectin, blood glucose levels, the concentration of certain blood lipids and lipoproteins, and body mass index in regular futsal players within the specified age range.
The researchers hypothesized that endurance and HIIT cardio training would have an impact on adiponectin levels, blood glucose, lipid and lipoprotein concentrations, and body mass index in the study sample. The experiment was conducted on regular futsal players aged 45–55 years at the Physiology Laboratory and sports fields of the College of Physical Education and Sports Sciences at the University of Al-Qadisiyah. Gene expressions of the adiponectin gene and biochemical variables were analyzed in the researcher's scientific laboratory.
The most significant conclusions of the study indicated that endurance and HIIT cardio training increased the gene expression of adiponectin, which in turn correlated with weight reduction in the sample. Furthermore, these training methods contributed to a decrease in harmful cholesterol levels (VLDL, LDL) and blood glucose, and an increase in beneficial cholesterol (HDL). The researchers recommended greater emphasis on structured endurance and HIIT cardio training for retired athletes to help maintain healthy body weight, ensure overall health, and reduce the risk of chronic diseases such as diabetes and hypertension.
Keywords: Endurance training, HIIT cardio, Adiponectin gene expression, Body mass index (BMI), Futsal players, Lipid profile, Physical activity, Gene expression.

1. INTRODUCTION:

One of the pressing modern-day problems affecting human life is the issue of weight gain and the associated health risks faced by individuals suffering from excess weight. The World Health Organization (WHO) has repeatedly warned about the dangers of excessive weight gain due to its strong correlation with chronic diseases such as diabetes, hypertension, and cardiovascular problems. This phenomenon can be attributed to several factors, including the accelerated pace of daily life, the prevalence of fast food in modern diets, sedentary office work, and a general lack of consistent physical activity. Additionally, discontinuing exercise while maintaining the same caloric intake—due to internal physiological adaptations such as stomach size, hormonal balance, and enzyme secretion further exacerbates the issue.
Many individuals affected by obesity resort to quick-fix weight loss methods, bypassing physical activity and dietary discipline. Surgical interventions such as gastric sleeve procedures, gastric bypass, stomach balloons, and

certain medications are increasingly sought after, often without full consideration of their potential side effects. In contrast, exercise remains one of the most effective and sustainable approaches to managing obesity, especially when paired with proper dietary habits. Weight loss programs should therefore be built on structured physical activity regimens, particularly those emphasizing aerobic metabolism. In these aerobic systems, the primary sources of energy are carbohydrates and fats, and to a lesser extent, proteins. Fat is especially important during prolonged physical exertion, making endurance training and HIIT cardio essential components in the metabolic breakdown of excess body fat.

The human body requires various sources of energy—carbohydrates, fats, or chemical compounds to carry out any form of physical activity, with the energy source depending on the nature of the activity. Hormones play a crucial role in regulating body functions during exercise. Among these hormones is adiponectin, which is central to this study. Adiponectin regulates metabolic functions in both muscles and the liver, supports carbohydrate metabolism, promotes fatty acid oxidation, and reduces triglyceride levels. These functions represent part of the physiological and biochemical adaptations that result from training under various physical loads.

Hence, the significance of this research lies in examining the impact of aerobic-based training programs—specifically endurance training and HIIT cardio—on the gene expression of adiponectin, a hormone that regulates lipid metabolism and exhibits high insulin sensitivity. The study focuses on how these training modalities influence key biochemical changes in regular athletes, contributing to the maintenance of health and the prevention of disease.

Through the researcher's observation, most athletes experience weight gain after retirement due to cessation or significant reduction of training and physical activity, which negatively affects their body weight and composition. This, in turn, impacts their health status and increases the risk of cardiovascular diseases such as hypertension and diabetes. The World Health Organization has established a specific index based on body mass index (BMI) to classify obesity rates. Hormones in our bodies are directly linked to obesity levels, with adiponectin being one of the most important hormones responsible for regulating lipid metabolism. The secretion level of this hormone can be directly influenced by exercise and physical activity.

The effectiveness of exercise programs can be evaluated by measuring adiponectin levels along with certain blood lipids and lipoproteins. The most important types of these exercises focus on improving cardiovascular and respiratory function, commonly known as cardiorespiratory fitness. Hence, the research problem is: What is the effect of endurance and HIIT cardio training on the gene expression of adiponectin and on selected blood lipids and lipoproteins in regular athletes aged 45–55 years?

Objectives:

1- To identify the effect of endurance and HIIT cardio training on the gene expression of adiponectin in the blood.

2- To determine the impact of endurance and HIIT cardio training on blood glucose, the concentration of certain lipids and lipoproteins, and body mass index in regular futsal players aged 45–55 years.

a. Hypotheses:

1. There is an effect of endurance and HIIT cardio training on the concentration of adiponectin hormone in the blood of regular futsal players aged 45–55 years.

3- Endurance training has an effect on blood glucose levels and the proportions of lipids and lipoproteins in the blood of regular futsal players aged 45–55 years.

Fields:

Human Field: The human field included the research sample consisting of (10) regular futsal athletes aged 45–55 years.

Temporal Field: The period from 2/2/2025 to 2/5/2025.

Spatial Field: The fields and laboratories of the College of Physical Education and Sports Sciences – University of Al-Qadisiyah, and the researcher's scientific laboratory.

2. Methodology Sample:

In order to arrive at scientific and objective facts, it is necessary to choose the appropriate research method. Therefore, the experimental method was used because it was suitable for the nature of the problem to be solved. (Jaber Abdul Hamid: 1996, p. 140)

The research sample was defined as regular futsal athletes aged 45–55 years who were overweight. The study was conducted on participants engaged in fitness training aimed at weight loss and general health improvement. The sample consisted of (10) athletes regularly involved in futsal; all focused-on health and weight reduction.

To ensure the sample's suitability and that it follows a normal distribution for certain variables relevant to the research topic—variables that significantly affect the validity and accuracy of the results—homogeneity tests were conducted. These tests examined the sample's consistency in terms of age, weight, and height. The coefficient of variation was used to confirm the homogeneity of the sample, and the skewness coefficient was applied to verify that the sample data were normally distributed, as shown in Table (1).

3. Table (1) shows the homogeneity and moderate distribution of the research sample.

Variables	Mean	Standard Deviation	Coefficient of Variation (%)	Skewness

Age (years)	51.92	6.74	16.11	-0.14
Weight (kg)	101.26	9.69	11.09	0.27
Height (cm)	177.85	4.84	2.35	0.22

4. Identification of study variables:

The variables were identified by the researchers through a thorough review of the literature and reliable scientific sources, as they contribute to addressing the research problem. The study variables included the following:

First: Gene expression of adiponectin.

Second: Biochemical variables (triglycerides (TG), cholesterol, HDL, LDL, VLDL, and blood glucose).

Third: Body Mass Index (BMI).

Fourth: Physical exertion test using a treadmill to measure biochemical variables:

A range of physical exertion protocols was proposed to experts and specialists in sports training to select the most appropriate ones that align with the nature of the study and the physical fitness level of the research sample. The exertion involved continuous exercise on the treadmill for six minutes, with changes in speed every two minutes. After conducting exploratory trials to determine which exertion levels best suited the sample, the speeds of 6, 8, and 10 km/h were selected. Biochemical variables were assessed by drawing blood samples after each exertion test at various stages of the training program.

5. Exploratory experience:

The pilot experiment was conducted on Wednesday, January 15, 2025, at 9:00 AM in the Physiology Laboratory of the College of Physical Education and Sports Sciences. It involved two participants from the research sample. The purpose of this pilot was to gain insights for the main experiment, identify potential challenges the researchers might face during its execution, and determine the time required to complete the experiment.

6. Main experiment:

- Laboratory measurements:

1- Blood samples were collected from the research sample consisting of (10) regular futsal athletes aged 45–55 years. Venous blood samples of 5 cc were drawn after physical exertion on the treadmill. The samples were placed in tubes, then stored in a cooling box, and subsequently transported to the laboratory. The participants underwent an 11-hour fasting period prior to blood collection for analysis of adiponectin gene expression and biochemical variables (blood glucose, triglycerides (TG), cholesterol, HDL, LDL, VLDL) by a chemical specialist. The blood was placed in medical tubes and then transferred directly to the researcher's laboratory for training and research in Diwaniyah city for analysis of these levels.

2- Measurement of Body Mass Index (BMI), sometimes referred to as the Quetelet Index after the Belgian mathematician Adolphe Quetelet who first introduced it. BMI is calculated by dividing body weight in kilograms by the square of height in meters, according to the following formula:

- Preparing and conducting training sessions (endurance and cardio):

Phase One: The researchers prepared and organized endurance training programs based on various sources, references, and literature, as well as consulting with experts and specialists.

Phase Two: Endurance training was applied to the research sample for three months, with three training sessions per week, from 02/02/2025 to 02/05/2025. The training load components considered the participants' training level and age. The endurance training was regulated on a scientific physiological basis, considering physical capability and the equipment used to induce changes in the gene expression of adiponectin, certain blood lipids and lipoproteins, body mass index, and physical fitness of regular futsal athletes aged 45–55 years. The goal was to achieve the training objectives by reducing weight. Heart rate was used to determine exercise intensity, along with repetitions and rest periods between exercises or sets.

The details of the exercises are as follows:

- Endurance training (long-distance running and brisk walking): Training intensity ranged from 60% to 70%, with two repetitions. The first repetition was at the start of the training session lasting 10 to 15 minutes, and at the end of the session lasting 10, 15, 20, or 25 minutes. The duration gradually increased from the shortest to the longest as physical fitness improved. The program started with 10 minutes at the beginning and 10 minutes at the end of the first session, then time was progressively increased.
- HIT cardio exercises involved 8, 10, or 12 exercises per training session with three repetitions depending on the sample's capacity. During the first four weeks, each exercise lasted 10 seconds with 10 seconds rest per exercise, and 1 minute 30 seconds rest between sets. During the second four weeks, exercises lasted 15 seconds with 10 seconds rest per exercise, and 1 minute 30 seconds rest between sets. In the last four weeks, exercises lasted 20 seconds with 10 seconds rest per exercise, and 1 minute 30 seconds rest between sets. The exercises targeted various body parts with a steady rhythm from beginning to end, including: (Jumping Jack- Under Knee Clap – Elbows To Knees – Squat Jump – Ankle Tap – Knee Lift – High Knee – Butt Kick – Seated Knee Tucks – Alternating Leg Swings – Bicycle Crunches – Supine Crunch – Supine Overhead Press – Supine Leg Scissors – Plank Jacks – Mountain Climbers – Shoulder Taps – Knee Touch Plank - Low Cruncg – High Crunch).

- Post-tests:

The researchers, with the assistance of the supporting staff and medical team, conducted the post-tests on the study sample following the completion of the training program, adhering to the same sequence of tests as the pre-tests. The researchers ensured that the conditions under which the post-tests were conducted matched those of the pre-test phase to maintain consistency and reliability of the results.

7. Statistical methods used:

Researchers use the statistical package (SPSS) to analyse research results.

8. Presentation and analysis of pre- and post-test results for endurance and hit cardio exercises, gene expression of adiponectin, biochemical variables, and body mass index for the study sample:

Table (2) presents the means, standard deviations, calculated (t) values for paired samples, significance levels, and the statistical significance of the differences between the pre-test and post-test for (endurance and HIIT cardio) exercises regarding the gene expression of adiponectin and the biochemical variables.

Variables	Unit of Measurement	Pre-test Mean ± SD	Post-test Mean ± SD	Calculated Value (t)	Significance Level (p)	Statistical Significance
Adiponectin gene expression	(2^-ΔΔCT)	1.379 ± 0.803	10.607 ± 1.224	19.635	0.00	Significant
Blood glucose	mg/dl	127.44 ± 3.17	109.09 ± 5.26	9.67	0.00	Significant
Triglycerides (TG)	mg/dl	138.31 ± 21.65	61.72 ± 14.52	8.59	0.01	Significant
Cholesterol	mg/dl	229.57 ± 14.84	169.31 ± 11.26	12.50	0.00	Significant
HDL	mg/dl	41.33 ± 7.75	59.27 ± 5.27	8.98	0.02	Significant
LDL	mg/dl	147.71 ± 14.93	106.00 ± 8.96	9.01	0.02	Significant
VLDL	mg/dl	36.07 ± 5.23	16.11 ± 3.30	6.62	0.00	Significant
Body Mass Index (BMI)	kg/m²	31.96 ± 2.68	26.25 ± 2.46	27.54	0.00	Significant

Based on Table (2), it is evident that the differences favor the post-test results for adiponectin hormone levels. The researchers believe that this change in the gene expression of adiponectin in the study sample is a direct result of the training programs designed by the researchers (endurance training and HIIT cardio). These programs positively influenced the gene expression in favor of the post-test. The gene expression of adiponectin is affected by training intensity, particularly at high intensities, as the training units were conducted at high performance intensities over a period of 12 weeks. This duration and intensity likely necessitated an increase in hormone secretion. This conclusion aligns with Muhammad Al-Qat (2022, p. 82), who states that "many hormones have been proven to increase in level with physical exertion." Additionally, hormonal concentration responses correlate with individuals' fitness levels, where increases in trained individuals are lower compared to untrained individuals.

Regarding blood glucose, the results were also statistically significant in favor of the post-test. The endurance training, conducted at regulated intensities appropriate for the players' ages, combined with HIIT cardio training, contributed to a reduction in blood glucose levels after the training period. The researcher agrees with Samia Khalil's explanation that "insulin increases with elevated glucose levels, and thus insulin controls the source of energy (carbohydrates and fats), both of which are critically important for sustaining and continuing physical activity and the muscular contractions it requires. Glucose plays a major role in short-duration activities, while fats are important during prolonged and intense physical exertion such as long-distance races. Insulin regulates glucose transport from the bloodstream to tissues during physical activities and increases glucose storage while replenishing the consumed glucose during exercise. Due to the increased demand of muscles for glucose in moderate-intensity physical activities, blood glucose levels decrease and are compensated over time by converting glycogen into glucose in the bloodstream" (Samia Khalil, 2008, p. 401).

Regarding triglycerides, the researchers attribute the observed improvement to the endurance training and the variety of HIIT cardio exercises conducted during the training period, which played a positive role. The specific selection of these exercises was tailored to match the participants' capabilities and the duration of the training, which was sufficient to induce changes in the study sample. Continuous endurance training played a primary role

in reducing lipid and lipoprotein levels due to its specificity and impact, as the training intensity was appropriate to the sample's fitness level, performed at a consistent pace, over a prolonged and continuous period.

Additionally, HIIT cardio exercises engaged large muscle groups with minimal rest between repetitions and sets, requiring significant muscular effort across multiple muscle groups due to their diversity and intensity. This results in fat burning across various body regions. Regular and sustained training increases the secretion of catabolic hormones associated with exercise, which contribute to fat metabolism in adipose tissues and explain the fat loss commonly observed with continuous training (Abu Al-Ala Ahmad, 1997, p. 386). Diane Dahm and Jane Smith note that the longer the duration of physical activity, the more fat the body utilizes (Diane Dahm & Jane Smith, 2006, p. 30).

Endurance and HIIT cardio exercises enhance oxygen delivery to working muscles; thus, despite the reduction in fat, the working muscles maintain their strength. Consequently, the reduction occurs at the expense of fat rather than muscle mass. A'id Abdullah, citing Osama Kamel, confirms that physical activity ensures weight loss primarily from accumulated fat rather than muscle atrophy (A'id Fadhlallah, 2000, p. 34).

Regarding cholesterol, the researchers note that although statistically significant differences were observed, all values remained within the normal reference range, indicating functional efficiency and effective regulatory mechanisms controlling cholesterol levels. The researchers believe that endurance training and HIIT cardio influenced blood cholesterol levels, as these exercises relied on cholesterol metabolism to provide the necessary energy during training loads, especially after the depletion of glycogen stores in the liver and muscles, as well as glucose in the blood. This finding aligns with Cleeman and Lenfant's view that scientifically structured physical exercise reduces total cholesterol levels.

Concerning HDL cholesterol, known as the "good" cholesterol, a difference was observed between pre-training and post-training tests following endurance and HIIT cardio exercises. Physical exertion and regular exercise help increase HDL cholesterol levels, while physical inactivity may lead to increased levels of "bad" cholesterol and decreased levels of HDL cholesterol. Regular physical activity can raise HDL levels and lower triglycerides in the blood (Hazaa Bin Ahmed, 2010, p. 608). The study sample likely relied more on alternative energy sources in addition to carbohydrates due to the high training intensity. This corresponds with the observed increase in HDL cholesterol among the players, which contributes to energy release during exercise. Hazaa also confirms that physical exertion and regular training increase HDL cholesterol levels (Abu Al-Ala Ahmad, 2003, p. 123).

The primary function of high-density lipoprotein (HDL) cholesterol is to transport other lipids in the blood plasma, such as low-density lipoproteins (LDL), triglycerides, and phospholipids, to the liver for metabolism and elimination. Therefore, HDL cholesterol is referred to as "good cholesterol" because it removes LDL cholesterol from the blood vessels and delivers it to the liver, where the body disposes of it and prevents its harmful effects. Specialists recommend maintaining regular exercise to preserve healthy levels of good cholesterol and to eliminate the harmful cholesterol. The HDL cholesterol level should not fall below 40 mg/dL in the blood. For example, individuals who consume fish oil supplements can experience an increase in HDL cholesterol levels up to approximately 100 mg/dL. HDL benefits the body by transporting harmful LDL cholesterol to the liver, where it is converted into bile acids that aid digestion. In other words, "good cholesterol" transforms harmful cholesterol into a beneficial acid and, importantly, prevents its damage to the body (Abu Al-Ala Ahmad, same source, p. 126). Physical inactivity causes an increase in bad cholesterol (LDL) and a decrease in good cholesterol (HDL). Regular physical activity can raise HDL cholesterol levels in the blood and lower triglyceride levels.

Regarding the Body Mass Index (BMI), Table (2) shows significant differences in favor of the post-test, resulting from the endurance and HIIT cardio training applied to the study sample. The researchers attribute these results to the training program, which effectively increased physical activity levels through the participants' engagement in endurance and HIIT cardio exercises. This regimen helped maintain muscle mass while reducing body fat percentage. Moreover, the exercises promoted the oxidation of stored fats in the body to provide the necessary energy for physical activity, facilitated by the increased gene expression of adiponectin. It is well-known that adiponectin inversely correlates with obesity and plays a crucial role during physical activity by enabling the muscles to utilize fat as an energy source. The relationship between body fat and muscle tissue is closely linked to overall physical fitness, with each influencing the other. Therefore, the endurance and HIIT cardio exercises designed by the researchers had a direct impact on improving the BMI (Saja Zuhair, 2024, p. 59).

The researchers also believe that the reduction in BMI is due to the positive effect of endurance and HIIT cardio training on enhancing the health-related fitness level of the participants. The exercises were scientifically structured to mimic the natural functioning of the body's muscles, which in turn influenced weight reduction and lowered body fat percentage. Reducing body weight alleviates joint pressure, while endurance and HIIT cardio training contributed to lowering body fat levels and, consequently, body weight. This effect is attributed to the positive influence of the applied exercises in decreasing fat levels and achieving lower values compared to the pre-test (Hazaa Al-Hazaa: previously cited source, p. 600).

9. CONCLUSIONS:

1- Endurance and HIIT cardio training increased the gene expression of adiponectin, which consequently contributed to the observed weight reduction in the study sample.
2- Endurance and HIIT cardio training played a significant role in reducing levels of harmful cholesterol and blood glucose (VLDL-LDL), while increasing the level of beneficial cholesterol (HDL) in the study sample.
3- Endurance and HIIT cardio training, along with the elevated adiponectin hormone levels, contributed to the reduction of the Body Mass Index (BMI).

10. RECOMMENDATIONS:

1- Emphasize the importance of structured endurance and HIIT cardio training for athletes' post-retirement to maintain their body weight, promote health safety, and reduce the risk of chronic diseases such as diabetes and hypertension.
2- Conduct evaluation and measurement of adiponectin gene expression as a precise biomarker for assessing the physical condition and obesity status of athletes experiencing weight gain.
3- Promote a culture of regular screening for the studied variables to prevent or reduce the risk of chronic diseases.

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