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A Study of the Effect of Resistance Training on Kidney Function in Female Rats Treated with Different Sex Hormones

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Annotation: The current research aims to study the efficacy of resistance training in protecting and maintaining kidney function in female rats treated with sex hormone therapy.

The study sample consisted of a group of female rats classified into four groups based on the treatment method and the extent of resistance training. Some of these rats were injected with testosterone cypionate regularly, one injection every ten days, for a period of one and a half months.

The changes that occurred in the study sample were detected through microscopic blood and urine examinations.

The results showed that the training enhanced kidney cell resistance, reducing phagocytic cell proliferation and infiltration, and mitigating the risks of chemotherapy by improving kidney function.

Keywords: Resistance training, sex hormone therapy, kidney function, testosterone, kidney inflammation.

Introduction

Sex genes provide the basis for determining sex [1] and developing sex characteristics through regular hormone therapy [2]. The body is supplemented with male hormones, which leads to a

significant increase in their production. These hormones are administered to transgender men to develop their male characteristics [4][3]. However, this hormonal effect can lead to risks that may affect the arteries, heart, liver, and other organs. The complications this hormone causes on the kidneys are still being investigated, and it may pose risks to the renal vessels [5]. It also weakens the vascularity of the arteries connected to the capillaries in the kidney.

It is important in regulating thromboxane/prostaglandin levels [6], limits nitric oxide (NO) formation, promotes inflammatory processes [7], and helps deliver blood to the ischemic kidneys [8]. Hormone replacement therapy also has positive results in cases of hypogonadism [9]. However, this hormone can cause kidney damage and alter blood levels [10][11].

The importance of this research stems from its study of the relationship between hormone use in the study sample and resistance training, and the effect of these two parameters on kidney function in female rats

Research Problem

Doctors and specialists are finding it difficult to know the effect of resistance training on the kidneys of female rats treated with sex hormones and the efficiency of their functioning, especially in light of the negative side effects of these hormones on the kidneys and their blood vessels. Many studies have concluded that these hormones lead to the possibility of deterioration in kidney functions, while other studies have confirmed the benefits of hormone treatment. Hence, the urgent need to conduct an in-depth study on this subject.

Research Significance

The benefit of this research is to study the mechanism of effect of exercise training combined with added mixed hormones on the body, and the mechanism of effect of both training and hormones on kidney function and its ability to perform its functions optimally in the rat sample. This allows us to arrive at scientific facts that can be generalized, through which we can protect and preserve the kidneys in such cases.

Research Objectives

- Evaluating the effect of exercise and resistance training on kidney function in female rats treated with sex hormones.
- Comparing the hormone-treated rats to the untreated rats in terms of their kidney changes.
- Identifying changes in kidney tissue and chemistry resulting from the interaction between the administered hormone and resistance training.
- Determining the effectiveness of resistance training in preventing the side effects of hormones on kidney tissue.
- Providing recommendations for protecting the kidneys from the effects of hormones.

Systematic Review

The study (Collister & Levin, 2025) The study was based on experiments conducted on transgender people who were taking sex hormone therapy, and the results of the study showed that the hormone affected their kidneys, as well as blood flow in them and other negative effects.[12]

The study by Ibrahim (2022) aimed to understand the effect of using total-body resistance training on developing arm and leg endurance and some specific physical attributes of squash players. The researcher used the experimental method, as it was suitable for the type and nature of this research, through an experimental design using pre- and post-tests with a single experimental group. The research sample was selected purposively from junior squash players under 17 years of age from Al-Zuhour Sports Club, totaling (12) juniors, in addition to a pilot study sample of (8) juniors from Al-Ahly Sports Club, bringing the total sample to (20) juniors. Physical and skill tests were administered, and the results of the study showed that total-body resistance training for

12 weeks led to a noticeable improvement in some specific physical abilities for squash players, such as (flexibility, agility, strength endurance, and speed endurance), as well as an improvement in performance efficiency at the skill and tactical levels [13].

The added value of our study

The study provides new evidence that resistance training helps protect kidney function in female sex hormone-treated mice by improving kidney cell resistance and reducing inflammation, suggesting that physical training could be used as part of a preventative treatment for hormone therapy-related kidney problems.

Materials and Methodology

The study sample consisted of two-month-old female rats. These rats were fed and watered from the laboratory throughout the entire experiment. They were also provided with health identification and kept at a temperature of 22°C. They were exposed to light from 7:00 AM to 7:00 PM. The sample was divided into four groups. The first group consisted of rats given a transporter in the form of follicular ovarian hormone (FSO). The second group of rats also received FSO, but also estrogen cypionate intramuscularly at a dose of 3 mg/kg (FSH). The third group of rats received FSH but underwent progressively progressive resistance training (FEO) The last group was given FSH and the exercise was performed on them. Figure (1) illustrates the steps of the experiment.

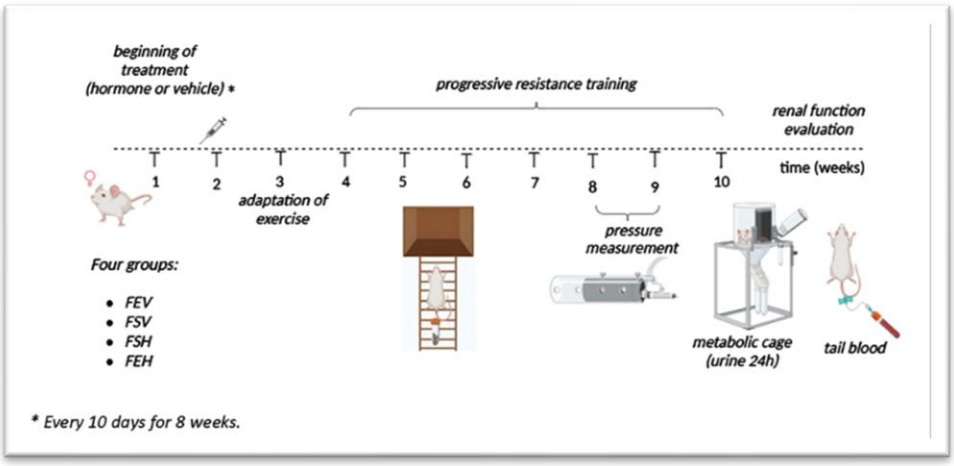

Figure (1) Experimental Procedure Diagram

The rats were trained to climb up and down a ladder for 72 hours, with a one-minute rest period between each exercise. After 72 hours, training began by having the rats carry weights proportional to their body weight. The weights were gradually increased until the rats collapsed and could no longer carry heavier loads. At that point, the heaviest weight they carried was recorded and called their maximum weight. These weights are recorded in Table 1.

Table (1) Maximum Loads According to Group

Maximum Load	Group
689.7	FEH
661	FEO

Blood pressure was measured for each participant in the sample five times, and the average reading was recorded. After a 96-hour rest period, kidney function was assessed. Urine and blood samples were collected and the amounts of sodium and potassium were determined. and other substances were measured, along with other tests to determine kidney function and its ability to perform its tasks. Following these various tests, which will be detailed in the results section, data was calculated and statistically analyzed for comparison and analysis.

A relationship was considered statistically significant when the value was equal to or less than 0.05. The results were illustrated through graphical representations.

Results

First, the results of changes in functional parameters:

The studied samples were weighed after hormone treatment. It was observed that the rats gained weight as a result of the hormones and exercise. A decrease in uterine weight was also observed, attributed to the effect of testosterone, which reduces the production of female hormones. However, when examining the group of samples treated only with resistance training, The weight of the uterus in the study sample also decreased. Table (2) shows the changes in all studied parameters for the four groups of studied samples.

Table (2) Urine and blood tests of study samples

Laboratory	Control group (oil) (n = 13)	Hormone (n = 12)	Control group (oil) (n = 16)	Hormone (n = 12)	Interaction	The effect of exercise	Hormone effect
Body weight (g)	244.7 ± 5.60	281.2 ± 9.08	251.4 ± 7.83	273.5 ± 4.95	p = 0.2983	p = 0.9736	p = 0.0274
Nose and rectum length (cm)	"22.056 ± 0.213"	"23.345 ± 0.46*"	"22.400 ± 0.32"	"22.623 ± 0.15"	"p = 0.10312"	"p = 0.56915"	"p = 0.02344"
Li index (g/³/cm)	283.7 ± 2.11	280.8 ± 3.51	281.8 ± 3.13	286.9 ± 1.75	p = 0.1629	p = 0.4684	p = 0.6978
Kidney weight (g)	2.62 ± 0.19	2.55 ± 0.11	2.78 ± 0.07	2.57 ± 0.07	p = 0.4523	p = 0.4130	p = 0.0778
Ovarian and uterine weight (g)	"1.111 ± 0.076"	"0.627 ± 0.110*"	"0.936 ± 0.026"	"0.856 ± 0.045"	"p = 0.04366"	"p = 0.87576"	"p = 0.01069"
Ovarian and uterine volume (% of body weight)	0.45300 ± 0.0119	0.2336 ± 0.0324*	0.4216 ± 0.0333#	0.3348 ± 0.0218	"p < 0.001"	"p < 0.001"	"p < 0.001"
Blood pressure (mmHg)	"119.12 ± 1.26"	"117.63 ± 4.16"	"119.53 ± 3.41"	"128.22 ± 3.88"	"p = 0.32004"	"p = 0.32109"	"p = 0.87202"
Blood pH	"7.316 ± 0.0112"	"7.378 ± 0.0614"	"7.33 ± 0.0115"	"7.355 ± 0.0113"	"p = 0.86302"	"p = 0.03838"	"p = 0.27255"
Carbon dioxide (mmHg)	"46.120 ± 1.33"	"45.828 ± 3.04"	"53.521 ± 3.23"	"50.011 ± 2.59"	"p = 0.54022"	"p = 0.03356"	"p = 0.46613"
HCO3− (mmol/L)	26.13 ± 0.90	26.58 ± 0.88	28.17 ± 1.18	27.14 ± 0.61	p = 0.4202	p = 0.1605	p = 0.7451
Hematocrit (%PCV)	41.11 ± 1.77	42.50 ± 1.16	40.29 ± 0.94	42.25 ± 0.59	p = 0.8228	p = 0.6758	p = 0.1983
Creatinine (mg/dL)	244.71 ± 5.60	281.2 2± 9.08*	251.4 3± 7.81#	273.51 ± 4.95*	p = 0.61315	p < 0.001	p = 0.0001
Urea (mg/dL)	35.44 ± 1.67	36.79 ± 1.47	38.13 ± 0.99	39.50 ± 1.77	p = 0.9940	p = 0.0962	p = 0.3932
[Na+p] level in (mmol/L),	"148.2 ± 1.21"	"154.7 ± 0.97*"	"143.9 ± 0.595"	"145.6 ± 0.96*"	"p = 0.0335"	"p < 0.0001"	"p = 0.0005"
[K+p] concentration in (mmol/L),	"3.861 ± 0.0851"	"4.142 ± 0.1245"	"3.673 ± 0.1231"	"3.940 ± 0.096"	"p = 0.67999"	"p = 0.14157"	"p = 0.06146"
Urine flow rate (ml/min/kg),	"0.032 ± 0.001"	"0.028 ± 0.003"	"0.032 ± 0.002"	"0.033 ± 0.002"	"p = 0.74020"	"p = 0.80103"	"p = 0.97921"
Na+ excretion rate in (mEq/24h).	"4.227 ± 0.122"	"3.094 ± 0.444"	"4.016 ± 0.271"	"3.621 ± 0.536"	"p = 0.34455"	"p = 0.69169"	"p = 0.03084"
Kautium excretion (mEq/24h)	13.02 ± 1.21	8.25 ± 0.61*	9.64 ± 0.54	8.3 ± 0.50	p = 0.0035	p = 0.9336	p = 0.0469

Second, regarding blood pressure:

Blood pressure in all samples was within normal limits, but the group treated with mixed hormones (type II) recorded a value higher than normal. This group also showed increased plasma creatinine ($p < 0.0001$) and sodium ($p < 0.0005$), and decreased serum sodium excretion.

Third, glomerular and hemodynamic parameters:

Figure 2 illustrates the glomerular and hemodynamic parameters. Creatinine clearance was significantly affected by both CHT treatment and exercise (Figure 2A). In contrast, inulin clearance was affected only by exercise (Figure 2B). The renal artery-to-lubrication ratio The CHT concentration decreased significantly, as shown in Figure 2E. The renal plasma ratio remained stable and unchanged, whether under hormone therapy or exercise (shown in Figures 2C and 2D).

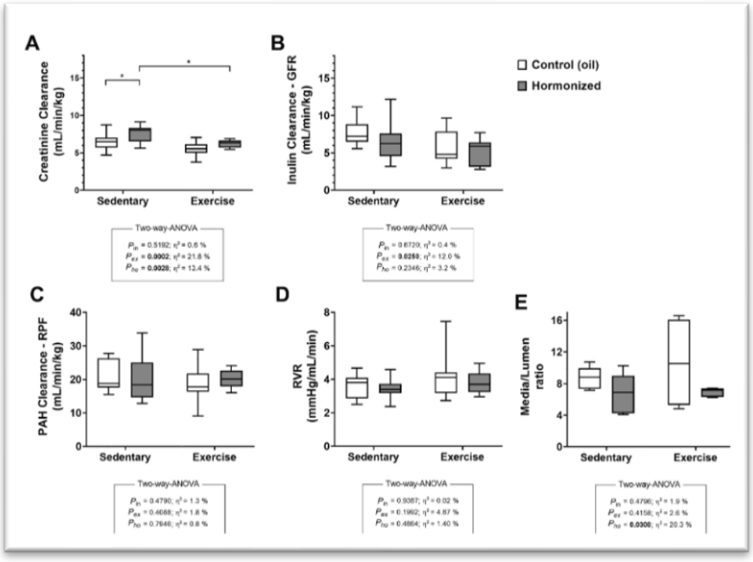

Figure 2: Glomerular and Hemodynamic Parameters

Fourth: Histological Analyses

The graphs in Figure 3 summarize the results of the renal injury measurements obtained from histological examination. The results showed a significant decrease in renal adenoid formation with both the combined chemotherapy and exercise program (Figure 3A). Resistance training also significantly reduced the number of phagocytic cells within the renal tissue (Figure 3C). In addition, physical activity contributed to a reduction The amount of positive cells and thus the reduction in the number of cells in the kidney tissue were observed (Figure 3D). We also did not find an effect on the alpha-actin level (Figure 3B).

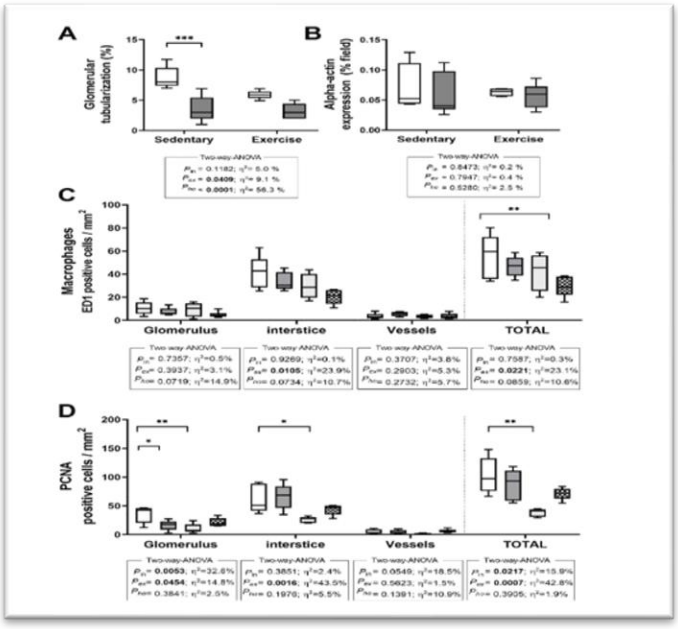

Figure (3) Histological Analyses

In general, the latest combination chemotherapy produced marked changes in kidney function, while resistance training provided protection by reducing markers of damage.

Discussion

The study evaluated the kidney function of a sample of rats, some treated with hormones alone, some with mixed hormones, some who underwent exercise, and some who received both mixed hormones and exercise. The results showed the following:

The studied hormone was found to have an effect on weight gain, and exercise was unable to counteract this increase. A decrease in uterine weight was observed with hormone treatment, indicating that these hormones reduce the effectiveness of female hormones. The treatment also increased the levels of creatinine and sodium in the blood and increased sodium levels in the urine. Physical activity in the body had a significant impact on kidney indicators, followed by a decrease in the proportion of phagocytic tissue in the kidney tissue and a decrease in the rate of glomerular tubule formation in the individuals in this sample. This led to an improvement in creatine levels and caused an improvement in the protein that contributes to muscle growth. This also played a significant role in the individuals in the second sample, and these activities had a notable effect in reducing the impact of the hormone, thus preserving kidney characteristics.

Conclusion, Recommendations, Suggestions, and Prospects for Future Work

The introduction of CHT into the bodies of female rats in the study sample significantly impacted kidney function. Exercise also played a role in mitigating the negative effects of this hormone, as it inhibited the growth of abnormal cells and promoted healthy cells, thus contributing to kidney health and efficiency. The study recommends continued and in-depth research on this topic to serve as a resource for physicians and researchers in treating patients receiving the studied hormones and understanding how to maintain kidney function based on the findings of this study.

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