CENTRAL ASIAN JOURNAL OF MEDICAL AND NATURAL SCIENCES

https://cajmns.casjournal.org/index.php/CAJMNS

Volume: 07 Issue: 01 | January 2026 ISSN: 2660-4159

Article

The Effect of Physical Activity on Physiological, Hematological, and Endocrine Functions in Search and Rescue Dogs

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Abstract: The aim of this research is to study and evaluate the normal post-exercise state of a dog, including its heart rate, respiration rate, blood components, and electrolyte levels. The study aims to determine when these increases or decreases are normal and when they indicate disease. A sample of dogs of different breeds and both sexes were used. They were trained for 20 minutes, and all these parameters were studied before and after training. The results were analyzed, concluding that it is normal for a dog's heart rate and respiration rate to increase during exercise, as well as for red and white blood cell counts to rise and electrolyte levels to decrease under conditions of fatigue and exhaustion. However, for these levels to be considered normal and for the dog to be healthy, they must return to normal after rest.

Keywords: dog, fatigue, tests.

1. Introduction

Several studies have been conducted to evaluate exercise-related changes in greyhounds [1], sled dogs [2], and Labrador Retrievers during recovery exercises [3], [4]. The effects of respiration, heart rate, and blood tests in dogs have been studied [5].

In fact, a delay in restoring heart rate after exercise in horses indicates fatigue resulting from inadequate physical fitness for the exercises performed [6].

Similarly, elevated heart rate and respiratory rate (RR) are normal post-exercise outcomes. However, response rate (RR) and response rate (RT) values may appear higher than expected in heatstroke, with serious complications for sport dogs [7].

Furthermore, the hyperthermia resulting from sustained muscular work negatively impacts muscle metabolism, significantly impairing performance [8]. In addition, exercise causes significant changes in certain laboratory parameters, which must be distinguished [9] as well as from mild dehydration due to water vapor loss in exhaled air for temperature regulation [10]. However, marked erythrocytosis is consistent with severe dehydration. This exertion-induced outcome not only affects the athletic performance of dogs but can also be life-threatening and require immediate medical intervention. White blood cell (WBC) levels increase during exercise [11]. Those who participate in various sports are more susceptible to illness than others, partly due to training stress and the release of immunosuppressive hormones, such as cortisol (CORT). These infections affect WBC dynamics Exercise also modifies several serum biochemical parameters. Lactate (LA), a metabolite derived from glycolysis pathways, is one of the most important biochemical

Citation: Saleh, K. H. The Effect of Physical Activity on Physiological , Hematological, and Endocrine Functions in Search and Rescue Dogs. Central Asian Journal of Medical and Natural Science 2026, 7(1), 399-407.

Received: 03th Sep 2025
Revised: 11th Oct 2025
Accepted: 19th Nov 2025
Published: 12th Dec 2025

parameters in sports medicine and is an indicator of the onset of fatigue [12]. Therefore, it is important from a medical perspective to identify the normal laboratory changes induced by exercise. The research presented here analyzes the exercise-induced changes in certain physiological and laboratory parameters during a search and rescue dog training session.

Research Problem

Dogs in general are susceptible to many diseases that hinder their ability to perform their work. Recently, concerns have arisen regarding the development of electrolyte imbalances in exercise dogs. Therefore, a distinction must be made between medical cases.

Importance of the Research

This research aims to identify the normal effects that may occur in dogs after fatigue and the effects that indicate the onset of disease.

2. Materials and Methods

The study used male and female dogs of different breeds in a 5:4 ratio. Various exercises were performed on this group after ensuring they were free from common diseases.

The dogs were found to be healthy and suitable for the experiment. Care was taken to provide the dogs with the appropriate and standard diet during the training phase. The dogs were trained by a group of trainers when they were 10 weeks old. They learned to follow the trainer's commands, perform search and rescue operations, and recognize human scent. Training sessions lasted from half an hour to an hour daily, three to five days a week. Training took place at least three hours after meals and at the end of the day, as well as at least half an hour after drinking water, to avoid any interference with the study results. The training took place in a large area of approximately 500 square meters at a temperature of about 22 degrees Celsius with a slight ambient temperature and 59% humidity with a slight ambient temperature. During training, the data shown in Table 1 was collected from the dogs in the study sample.

Table 1. Data collected from the dogs in the study sample after Training

Data types	Duration	Procedure
Heart rate (HR)	During exercise (5-second intervals)	Continuous measurement using a heart rate monitor (Polar Horse Trainer®), followed by computer analysis
Respiratory rate (RR) and rectal temperature (RT)	Not precisely defined	Conventional measurement
Venous blood samples	Before exercise, at rest (R), first 2 minutes after exercise (E), 5 REC, 15 REC, 30 REC	Blood is drawn from a vertical vein and stored in several tubes (EDTA-3K, lithium heparin, anticoagulant-free glass tubes)
EDTA blood assay	During the study	RBC, HB, PCV, MCV, MCH, MCHC, and WBC are measured using a semi-automated cell counter (Sysmex-F820)

Data types	Duration	Procedure
Heparin plasma assay	During the study	CrEAT, TPP, LA, GLU, TAG, CK, AST, LDH, chloride, sodium, and potassium concentrations are measured using spectrophotometry and flame photometry techniques
Serum cortisol concentrations (CORT)	During the study	Competitive immunoassay
Statistical analysis	After data collection	Logar-transformation of some variables, ANOVA for repeated samples, Tukey's test for difference, Pearson correlation, significance at $P<0.05$, using Statistica® software

3. Results and Discussion

After the dogs completed their training and were allowed to rest to ensure they showed no signs of fatigue or exhaustion, the necessary measurements and analyses were performed on the studied sample of dogs, categorized by the activities performed by each subgroup. Table 2 shows these tests and analyses.

Table 2. Physiological Data and Analyses of the Study Sample Dogs According to Activity Classification

Factor	Search and Rescue Dogs	Agility A, B	Sled Dogs^C	Sled Dogs^C	Sled Dogs^C	Labrador Retrievers
Distance or Exercise Time	20 minutes	100 seconds	100 miles	100 miles	100 miles	10 minutes
Heart Rate (bpm)	± 132.8 8.79	± 134.0 17.2	–	–	–	± 150.0 20.0
Respiratory Rate (bf/min)	± 196.0 50.9	± 174.0 46.4	–	–	–	± 183.0 34.0
Temperature (°C)	± 40.64 0.46	± 39.20 0.60	–	–	–	± 41.80 0.30
PCV (%)	± 53.16 0.64	± 51.60 5.59	–	–	–	± 51.00 3.00
WBC ($10^3/\mu L$)	± 13.73 4.78	± 8.310 1.40	–	–	–	± 10.30 1.90

Factor	Search and Rescue Dogs	Agility A, B	Sled Dogs^C	Sled Dogs^C	Sled Dogs^C	Labrador Retrievers
TPP (g/dL)	± 6.680 1.50	± 6.230 1.05	0.13 ± 5.800	0.13 ± 5.800	0.13 ± 5.800	–
CREAT (mg/dL)	± 1.580 0.16	± 1.370 0.26	0.600	0.600	0.600	–
GLU (mg/dL)	± 74.60 8.02	± 88.10 7.88	–	–	–	–
TAG (mg/dL)	± 82.90 16.3	± 75.80 17.7	–	–	–	–
LA (µmol/L)	± 5.030 0.68	± 4.550 2.31	1.265	1.265	1.265	± 3.570 2.20
Na (µmol/L)	± 142.8 5.89	± 147.9 12.8	1.00 ± 147.3	1.00 ± 147.3	1.00 ± 147.3	± 154.0 2.00
K (µmol/L)	± 4.060 0.57	± 4.630 0.84	0.12 ± 4.500	0.12 ± 4.500	0.12 ± 4.500	± 5.000 0.30
Cl (µmol/L)	± 109.0 13.0	± 115.5 15.4	2.10 ± 113.7	2.10 ± 113.7	2.10 ± 113.7	± 123.0 1.10
CK (µL/L)	± 108.0 143	± 43.13 36.9	472.9	472.9	472.9	± 143.0 65.0
AST (µL/L)	± 31.50 6.25	± 23.00 6.70	94.30	94.30	94.30	–
LDH (µL/L)	± 312.0 153	± 207.0 93.8	94.90	94.90	94.90	–
INS (µU/L)	± 16.20 7.00	± 13.30 11.0	–	–	–	–
CORT (µmol/L)	± 2.560 1.57	± 4.530 2.49	–	–	–	–

The mean standard deviations of these tests, both physiological and non-physiological, were also calculated, as shown in Figure 1, which illustrates these mean values for the dogs in the study sample after they had been trained in search and rescue for a third of an hour.

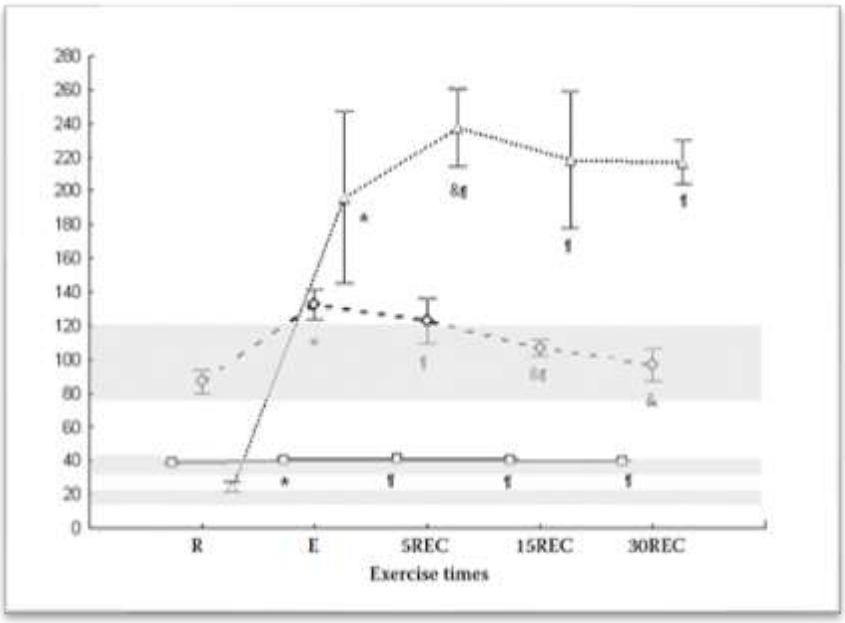

Figure 1. Mean Standard Deviation of Physiological Results

The colored area in the figure represents the standard values, i.e., the reference values against which comparisons can be made. Δ represents the respiratory rate measured in breaths per minute, ◊ represents the average heart rate in beats per minute, □ represents the temperature in degrees Celsius, * represents the difference between R and E, & represents the difference between E and REC, and finally ¶ represents the difference between R and REC.

Figure 2 shows the standard deviations of red blood cells (both types) after a 20-minute training session. ♦ represents the volume of acquired red blood cells, Δ represents white blood cells, * represents the difference between R and E, & represents the difference between E and REC, and ¶ represents the difference between R and REC.

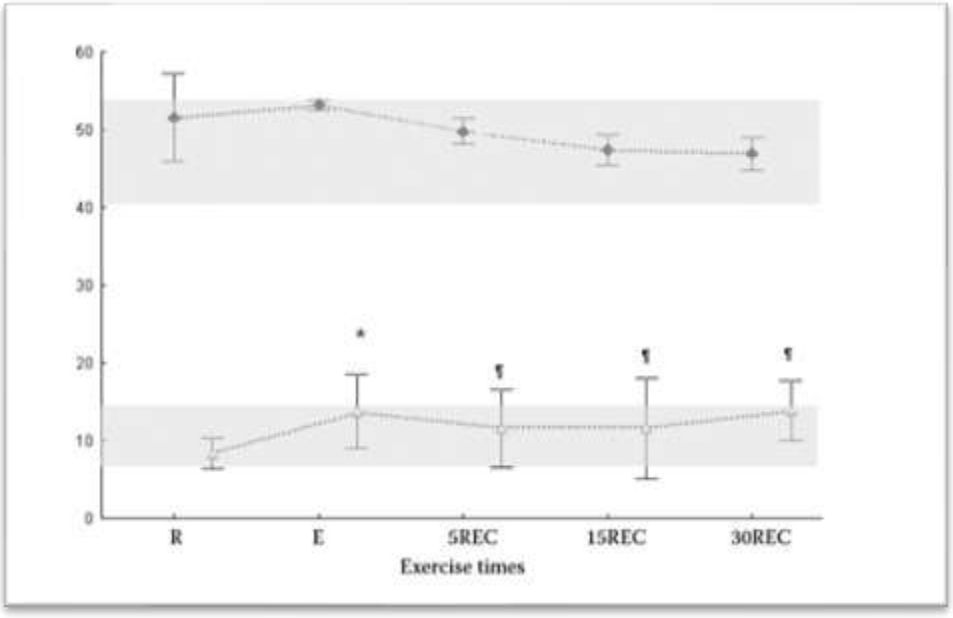

Figure 2. Mean Standard Deviation of Blood Cells

From Figures 3, 4, 5, and 6, we observe the mean standard deviations of the hydration indices in Figure 3, metabolism in Figure 4, lactate in Figure 5, and electrolytes in Figure 6**.**

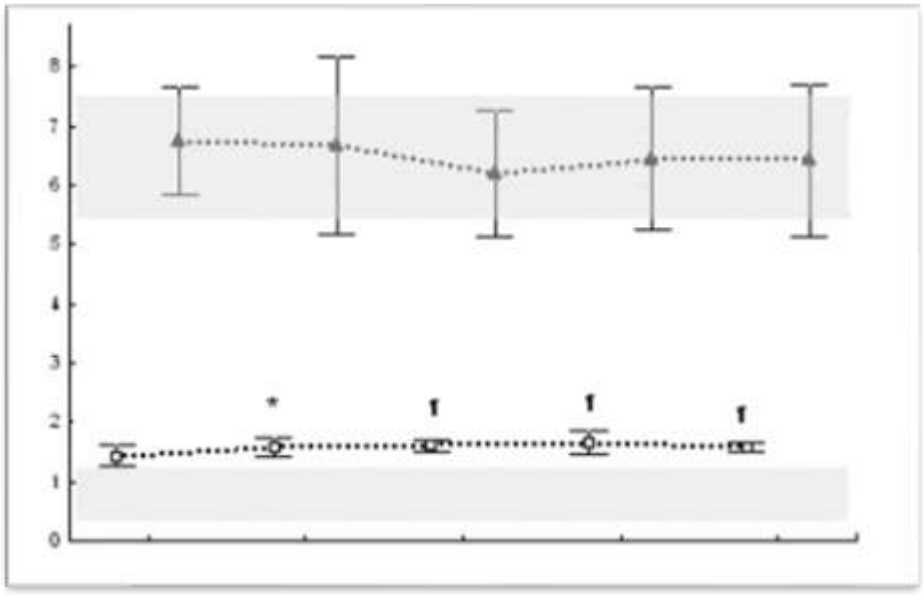

Figure 3. Average deviations of hydration indices.

As shown in Figure 3, plasma protein and creatine are expressed.

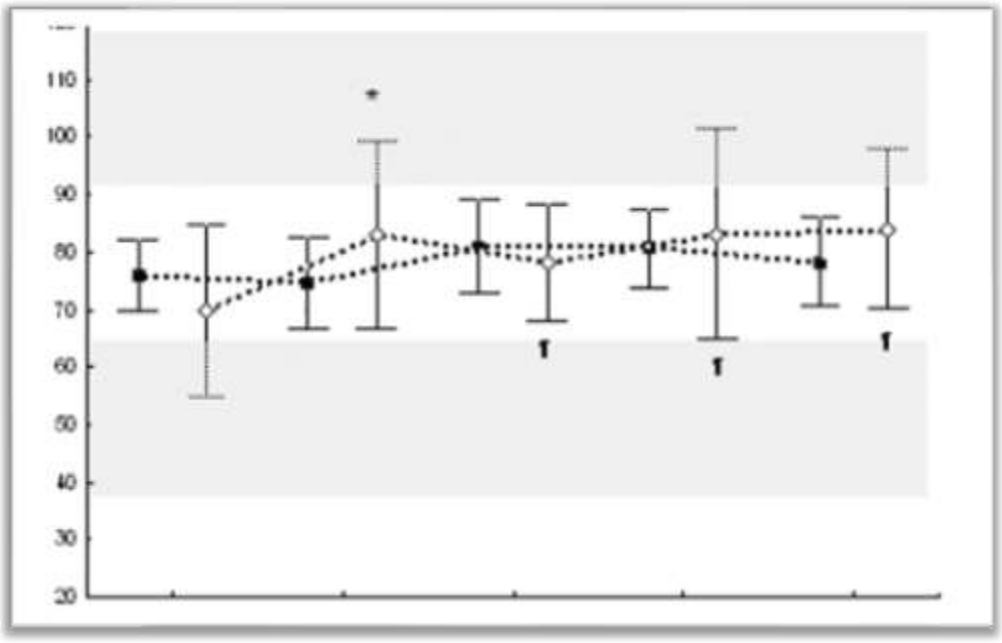

Figure 4. Mean deviations of metabolic indices

From Figure 4, glucose and triacylglycerol are expressed.

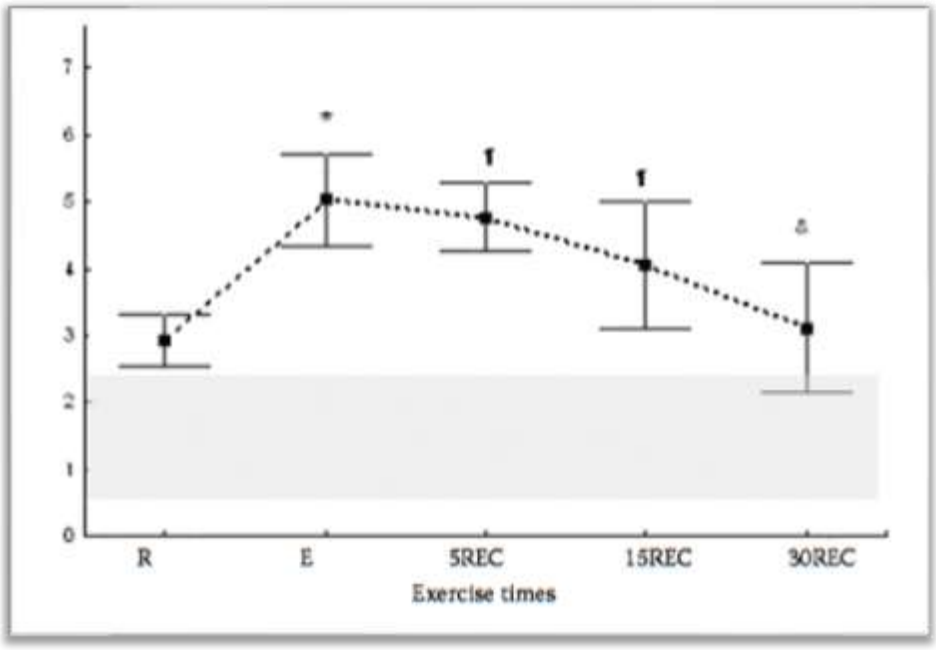

Figure 5. Average deviations for lactate

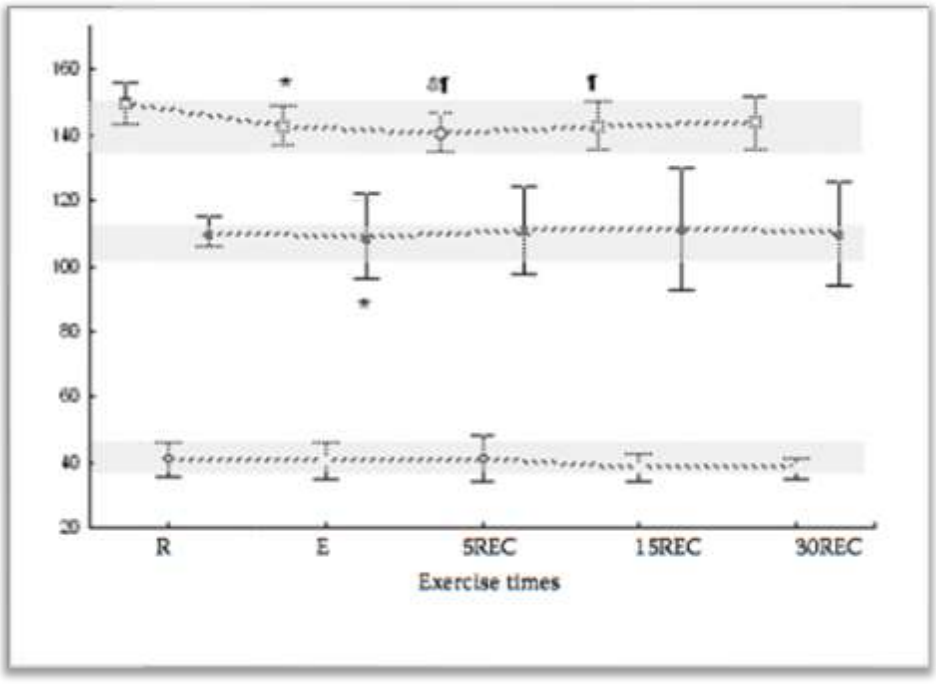

Figure 6. Average Deviations of Electrolytes

From Figure 6, we can see how sodium, chloride, and potassium ions deviate from the reference standard.

The average standard deviations of plasma muscle enzymes LDH, AST, CK, and hormones are also measured and shown in Figure 7.

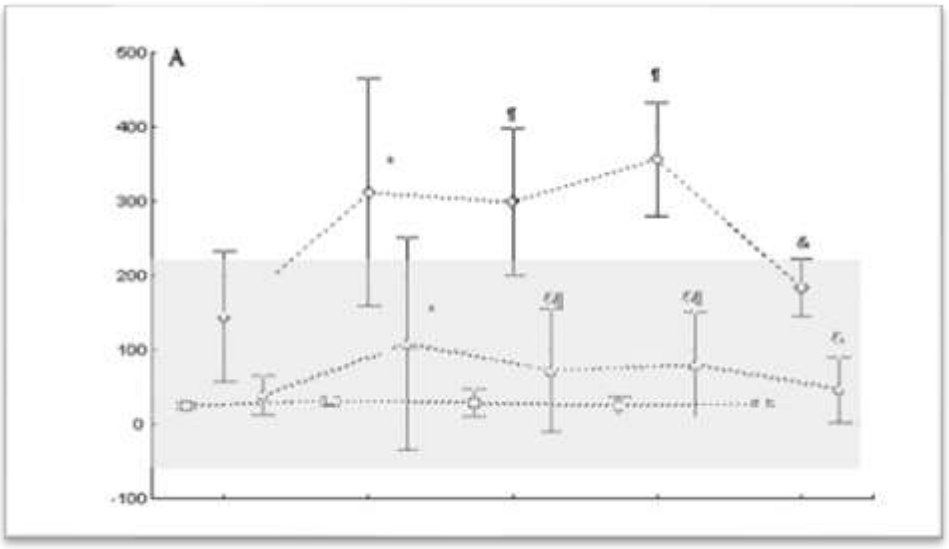

Figure 7 shows the mean standard deviations of muscle plasma.

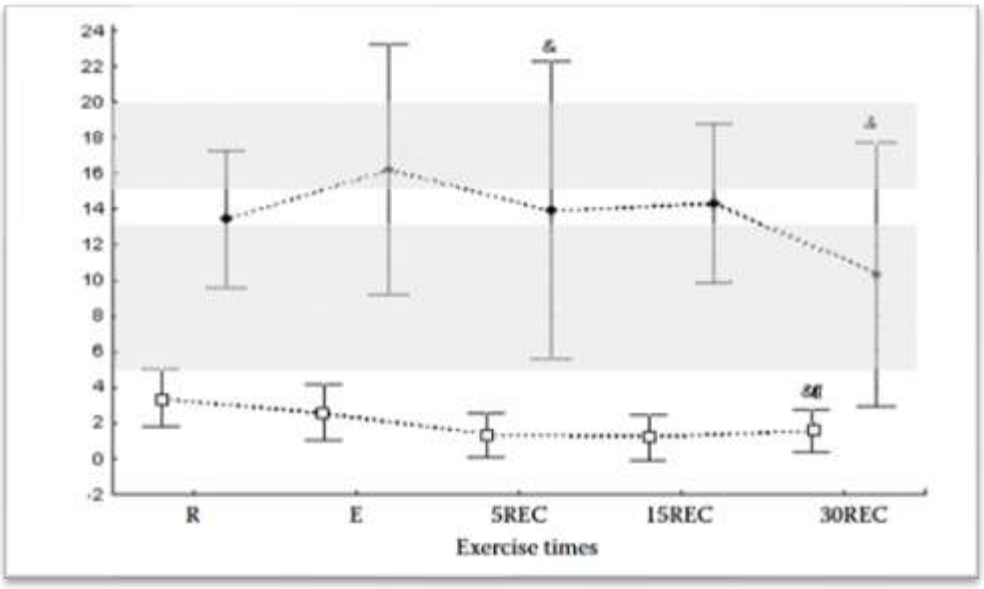

Figure 8. Mean Standard Deviations of Insulin and Cortisol

Figure 8 shows the mean standard deviations of both insulin and cortisol.

The results of the correlation coefficients between physiological, hormonal, and blood test results during the 15-minute training period are shown in Table 3. Table 3 in index 1. Correlation Coefficients Between Results

We observed that the most significant changes were in heart rate and respiratory rate. Blood cell counts were not significantly affected, except for MCV, which doubled after training. White blood cell count increased by approximately 1.5 times and remained elevated. While no significant increases were observed in chemical properties, TAG and CREAT both increased significantly by approximately 1.1 to 1.2 times. The greatest increases were in CK (2.8 times), LDH (2.2 times), LA (1.7 times), and INS (1.3 times).

Discussion

The aim of this research was to study and analyze what happens to dogs during exercise, identifying the normal effects or phenomena that occur in these dogs and are considered normal indicators, as well as those that indicate a risk of disease. The study revealed that the normal, disease-free state is characterized by changes in indicators such as heart rate, respiratory rate, electrolyte levels, and blood cell counts of various types.

These changes range from noticeable to slight and are due to oxygen deprivation resulting from exertion, as well as a noticeable increase in heart rate due to exertion and electrolyte depletion due to insufficient fluid intake. However, these changes are perfectly normal and do not indicate a disease unless their effects persist for an extended period after rest.

4. Conclusion

This study revealed the effects and indicators that are normal after exertion and fatigue in dogs, and those that indicate the onset of disease.

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