



The Favorable Effect of Swimming on Some Blood Parameters in Diabetic Rats

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Abstract: To investigate the effect of swimming on some hematological parameters in diabetic rats is the main goal of this study. 32 adult healthy rats were divided into Control (C), Diabetic (D), Exercise Control (E) and Diabetic+Exercise (DE) groups respectively. The rats in the control group were not soever treated, while the D and DE groups were injected 60 mg / kg streptozotocin (STZ) intraperitoneal (i.p). The trial continued for four weeks after the onset of diabetes. After the diabetes was formed, 1-hour swimming exercise for 4 weeks, 5 days a week was applied to groups E and DE during the trial period. At the end of the experiment (after 4 week) some hematological parameters (such as RBCs, Hb, Htc, platelet, WBC, differential leucocyte count) were determined in blood samples. RBCs, Hb and Htc values were reduced in D group. On the other hand, WBC and platelet count were increased in the same group. We observed RBC count, Hb and Htc levels were higher and WBC count was lower in DE group according to D group. As a result; current study was observed that regular aerobic exercise improves investigated parameters and demonstrates positive effects.

Keywords: Diabetes Mellitus, Exercise, Hematological Parameters, Rat, Swimming.

Diyabetik Sıçanlarda Yüzmenin Bazı Kan Parametreleri Üzerine Olumlu Etkisi

Öz: Diyabetik sıçanlarda yüzmenin bazı hematolojik parametreler üzerindeki etkisini araştırmak bu çalışmanın temel amacıdır. 32 yetişkin sağlıklı sıçan sırasıyla Kontrol (C), Diyabetik (D), Egzersiz Kontrolü (E) ve Diyabetik + Egzersiz (DE) gruplarına ayrıldı. Kontrol grubundaki sıçanlara hiçbir uygulama yapılmazken, D ve DE gruplarına intraperitoneal (i.p.) 60 mg / kg streptozotosin (STZ) enjekte edildi. Deneme, diyabetin başlamasından sonra dört hafta devam etti. E ve DE gruplarına, diyabet oluşturulduktan sonra, deneme süresini içeren 4 haftalık periyotta, haftada 5 gün olmak üzere 1 saat yüzme egzersizi yaptırıldı. Deneme sonunda (4 hafta sonra) kan örneklerinde bazı hematolojik parametreler (RBC, Hb, Htc, trombosit, WBC, diferansiyel lökosit sayısı gibi) belirlendi. D grubunda RBC, Hb ve Htc değerleri düştü. Diğer taraftan, aynı grupta WBC ve trombosit sayısı artmıştır. DE grubunda RBC, Hb ve Htc düzeylerinin daha yüksek, WBC sayısının ise daha düşük olduğunu gözlemledik. Sonuç olarak; çalışmada düzenli aerobik egzersizin incelenen parametreleri iyileştirdiği ve olumlu etkiler gösterdiği sonucuna varılmıştır.

Anahtar Kelimeler: Diabetes Mellitus, Egzersiz, Hematolojik Parametreler, Rat, Yüzme.

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INTRODUCTION

Diabetes Mellitus (DM) is a serious disease of metabolism which can be induced important problems because of the pancreas gland cannot produce insulin hormone adequately or the insulin hormone it produces cannot be used effectively (1). DM damages various organs, causing acute and chronic complications (2-4). Besides being a very serious and progressive disease, it causes acute and chronic complications when not controlled and negatively affects morbidity and mortality, resulting in a great health problem for both individuals and society (5). Along with rapid changes in lifestyle, DM prevalence is rapidly increasing across all developed and developing populations. The main causes of this increase in DM prevalence are population aging, unhealthy nutrition, obesity and sedentary lifestyles (4).

Physical activity and sport are extremely important for a healthy and long life. It can affect hematological and biochemical parameters as in many systems. Human physical adaptation to exercise is characterized by adaptation of cardiovascular system and alterations in hematological and biochemical parameters (1,6-8). The main goal of DM treatment is to protect or retard chronic complications of diabetes by optimally maintaining blood glucose, lipid profile and also blood pressure level. For blood glucose control, lifestyle changes such as exercise and diet are of primary importance. It improves glycemic control, lipid profile, immunity and decreases insulin resistance. On the other hand, physical training such as walking, cycling, running swimming can also play a role as a stress factor, stimulating the hypothalamic-pituitary-adrenal axis (1,9,10). Exercise has been considered an important therapeutic regimen in addition to nutrition and drug therapy in the treatment of diabetes mellitus for a long time (11,12). Regular physical exercises help to improve glycemic control while preventing diseases like cardiovascular disease, type 2 Diabetes mellitus

(T2DM) and also obesity. (13-15). Most activities such as walking, cycling, rowing, running, swimming and also jogging lead to aerobic energy consumption. Similar exercises such as these involve continuous and repetitive movements of large muscle groups (16). Aerobic exercise is very important because of its utility effects on most hematologic and biochemical parameters, as it decreases metabolism risk factors along with insulin resistance in the treatment of T2DM. Most studies on this subject have shown the favorable effects of aerobic exercise with distinct density on T2DM treatment (12,16).

The positive effects of regular exercise on metabolism are well known, but the role of exercise on diabetes is little known, and experimental diabetic rats are used as a human model for T2DM. Regular exercises are alternative treatment support programs for both type 1 and T2DM (12). Therefore, in the present study, we have examined the favorable and preventive effects of swimming exercise on some blood parameters in diabetic rats.

MATERIAL and METHODS

Animals and Treatment

In the present study, 32 healthy male Wistar Albino rats with weights of 280 ± 20 g and aged 70-80 days were used. Rats have been provided from the KONUDAM (Experimental Medicine Application and Research Center of Necmettin Erbakan University). The research design was approved by the KONUDAM Ethics Committee for Animal Studies (Ethics code: 2014-042). The rats were housed in plastic rat cages in the experimental animal unit at $23 \pm 2^\circ\text{C}$ at room temperature and in a $50 \pm 10\%$ humidified environment at a 12/12 night/day light cycle and they were fed ad-libitum with a standard rat diet. Rats were provided ad libitum access to water (~ 50 ml/day/rat) to be refreshed daily for four weeks.

The animals were divided into Control (C), Diabetic (D), Exercise Control (E) and Diabetic+Exercise (DE) groups respectively.

Induction of Diabetes

A single dose of streptozotocin (STZ) (60 mg/kg, Sigma S0130-1G) solution was injected intraperitoneally (i.p) in rats and a diabetes model was created in diabetic groups (D, DE) (17, 18). Group E and Group DE trained 5 d/wk for 4 weeks. The STZ solution was prepared by dissolving 60 mg / kg STZ (Sigma S0130-1G) in 0.1 M citrate buffer (pH 4.5) before application. After STZ injection, checking blood glucose was done after 72 h fast from the tail with blood glucose meters (plusMED). All the animals who obtained blood glucose above 250 mg/dl were contemplated diabetic. After 4 weeks of application, blood samples were taken from the animals by cardiac puncture under anesthesia into anticoagulant for determination.

Swimming Training Protocol

Swimming training program began after induction of diabetes. Swimming exercise was performed in the swimming tank (100x60 cm) ($32 \pm 1^\circ\text{C}$). The animals began experimental period that consisted of four weeks of the swim for 60 minutes, five days a week.

Hematological Analyses

Leucocyte (WBC), erythrocyte (RBC), differential leucocyte and thrombocyte (PLT) count, hemoglobin (HB) and hematocrit (HTC) levels were determined in blood samples. Hematological parameters were measured with Auto Hematology Analyzer (Mindray BC800).

Statistical Analyses

Statistical analysis of the obtained findings and determining the importance of the differences between the groups were made using the SPSS 16.0 package program. The significance between groups was determined Duncan's Multiple Range test in analysis of variance (ANOVA). Significant was considered as $P < 0.05$.

RESULTS

In this study, the effect of swimming exercise on some hematological parameters in STZ-induced diabetic rats were summarized Table 1 and 2. Diabetes reduced RBCs, Hb and Htc values, on the other hand WBC count and platelet increased significantly ($P < 0.05$) in D group.

Table 1. Some hematological parameters in experimental groups ($X \pm SX$).

Table 1. Deneý gruplarında bazı hematolojik parametreler ($X \pm SX$).

	C	E	D	DE	p
WBC($\times 10^3/\text{mm}^3$)	4.50 ± 0.20^c	6.52 ± 0.44^b	8.14 ± 0.57^a	6.94 ± 0.65^{ab}	<0.05
RBC ($\times 10^6/\text{mm}^3$)	8.19 ± 0.17^{ab}	8.86 ± 0.10^a	6.99 ± 0.50^b	7.18 ± 0.61^b	<0.05
Hb (gr/dl)	14.93 ± 0.27^{ab}	15.78 ± 0.31^a	12.26 ± 0.68^c	13.80 ± 0.58^b	<0.05
Htc (%)	48.25 ± 1.02^a	50.05 ± 1.55^a	36.28 ± 2.52^b	48.15 ± 3.26^a	<0.05
Plt (L)	779.83 ± 37.72^a	579.66 ± 82.02^b	832.66 ± 31.48^a	608.16 ± 62.03^b	<0.05

a, b, c; $P < 0.05$. WBC : White Blood Cel, RBC : Red Blood Cel, Hb : Haemoglobin, Htc : Hematocrit, Plt : Platelet.

Table 2. Differential leucocyte counts (%) in experimental groups ($X \pm SX$).

Table 2. Deneý gruplarında diferansiyel lökosit sayısı (%), ($X \pm SX$).

%	C	E	D	DE	p
Lym	70.37 ± 1.19^a	39.31 ± 10.13^b	73.15 ± 3.76^a	57.53 ± 6.21^b	<0.05
Mon	3.03 ± 0.70	4.02 ± 2.24	3.69 ± 1.00	6.81 ± 2.57	>0.05
Neu	24.75 ± 0.97^b	53.18 ± 7.59^a	21.30 ± 3.22^b	33.21 ± 5.41^b	<0.05
Eos	1.08 ± 0.27	1.65 ± 0.66	0.75 ± 0.46	1.04 ± 0.22	>0.05
Bas	0.81 ± 0.17	1.78 ± 0.88	1.53 ± 0.18	1.76 ± 0.43	>0.05

a, b; $P < 0.05$. Lym: Lymphocyte, Mon: Monocyte, Neu: Neutrophil, Eos: Eosinophil, Bas: Basophil

RBC count, Hb and Htc levels in the DE group was higher and total WBC count reduced than D group (Table 1).

Lymphocyte count was significantly increased and neutrophil count was reduced in diabetic group (D) compared with the other groups (especially E and DE Group). The basophile count was tending to increase in experimental groups compared with C group (Table 2).

DISCUSSION and CONCLUSIONS

Regular exercise is very important to prevent or treat many chronic diseases and their complications (8,19). DM is very important and serious chronic metabolic endocrine disorder and wants definitive therapy. Many studies on this subject reveal that exercise is effective in improving T2DM. While exercise can improve glycemic control, it can also increase insulin sensitivity and complications associated with reverse diabetes, such as cardiovascular damage, which is considered one of the main complications (12,20).

Aerobic exercise has positive effects on the hematological and biochemical parameters, such as cholesterol, triglyceride, insulin and glucose level and cytokines. Daily swimming training can be beneficial effects on blood parameters in diabetics (12,21). Some studies showed that exercise activities have significantly improved hematocrit, hemoglobin levels and RBC count in pregnant women, athletes, patients with T2DM, and STZ induced diabetic (36,38).

Ghisai et al. (22) have reported that leukocytes count was decreased and percentage of neutrophils were increased in exercise treated diabetic rats, while Crespilho et al. (1) said that there was no significant change in both total leukocytes counts and leukocyte counts in exercise- induced diabetic rats. Moreover, Nazıroglu et al. (23) have reported that leukocyte count was significantly increase in exercise treated diabetic rats when it compared to diabetic group.

Sugiura et al. (24) have reported that chronic exercise training improves the macrophage and

lymphocyte function. In this study, the increase in leukocyte count in exercised group is similar to the other results that founded in various studies (1,25). Chaar et al. (25) reported an increase in the leukocyte count due to mobilization of leukocytes and inflammatory responses which occur as a consequence of exercise. In this study, the increase in the number of neutrophils and monocytes in total leukocyte count was observed only in exercise group. McFarlin et al. (26) have reported that increasing in leucocyte count after exercise and remained the same for two hours. But Crespilho et al. (1) reported no differences between diabetic and exercise groups. On the other hand, some researchers reported an increase in lymphocyte, NK, T and B cell counts after exercise. Also, Neves et al. (27) and Kostycki et al. (8) informed that increase in leukocyte count depended on the period and density of exercise. Crespilho et al. (1) have observed that exercise affects opposite in increasing neutrophil count in diabetes. Eosinophil count may variate under stress. The increase in total leukocyte count in experimental diabetes may be due to an increase in free radicals, a decrease in antioxidant activity, and an increase in inflammatory cytokines.

In diabetic animals and humans, a relative decrease in lymphocyte ratios in leukocyte types and an increase in neutrophil count were observed (28-30). Kozlov et al. (28) reported moderate neutrophilic leukocytosis and prolonged circulation times of neutrophils and monocytes in diabetic mice and suggested that count may also show low-grade inflammation. But in this study, neither lymphocyte nor neutrophil ratios were significantly change had been observed. Our results were at the same consistent with the last literatures. Also, in some study, an increase in rate of lymphocyte in leukocyte types had been reported in diabetic animals (31).

It is well known that anemia occurred in chronic diseases. Increased lipid peroxide production and membrane protein oxidation in diabetes causes hemolysis of RBC resulting from hyperglycemia (30,32-34). Also, the observed parallel reductions in

RBCs, Hb and HTC values in diabetic animals group in the results of this study was reported in the results of some other researches (30,31,35,37). Increases in leukocyte and platelet counts with diabetes are consistent with studies conducted in this respect (32).

There were no significant changes in RBC count, Hb and Htc levels between control and experimental groups in our study and these findings were similar between Chaar et al. (25) and Crespilho et al. (1)'s results. Also, in this study the RBCs count, Hb and Htc levels in the ED group was significant highest than the D group, these levels in the exercise and D group was significantly lower than the E group. Also, there was a slightly increased in the levels of last previous parameters when we compared between exercise and diabetic group and only diabetic group, there is no mentions of importance between this two groups. After exercise, significant increasing in erythrocyte count may be the result of hemoconcentration (33).

In conclusion of this study, the results showed that the regularly swimming exercise performed in the experimentally diabetic rats with STZ has a positive effect on hematological parameters. Data obtained in this study could be used later as a basis to plan the duration, intensity and continuance of exercise as one of available modalities for treatment of diabetes mellitus.

Conflict of interest

The authors declare that they have no conflict of interest.

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