Original Article

# The Effect of Linseed Consumption on Blood Pressure and Laboratory Parameters in Healthy Adults who Exercise Regularly

**Kaptanoglu S[1], Tanritanır P*[2], Oto G[3], Yesilova A[4], Esen R[5], Ragbetli C[6], Dulger AC[7]**

[1]Yüzüncü Yıl University, Van Healthcare Services Vocational High School, Van, Turkey.
[2]Yüzüncü Yıl University, Van Health High School, Van, Turkey.
[3]Yüzüncü Yıl University, Medical Faculty, Department of Pharmacology, Van, Turkey.
[4]Yüzüncü Yıl University, Faculty of Agriculture Biometry-Genetic Department, Van, Turkey.
[5]Yuzuncu Yil University, Medical Faculty, Internal Medicine, Hematology Department, Van, Turkey.
[6]Yüzüncü Yıl University, Medical Faculty, Department of Microbiology, Van, Turkey.
[7]Yuzuncu Yil University, Medical Faculty, Department of Gastroenterology, Van, Turkey.

**Address for Correspondence**

Van Health High School,
Yuzuncu Yil University,
65080, Van, TURKEY.
Tel. +90 432 2251010.
**E-mail:** pinartanritanir@hotmail.com

## ABSTRACT

**Objective:** This study was designed to investigate the impact of linseed consumption on blood pressure and laboratory tests in healthy individuals who do and do not exercise regularly.

**Material and Method**: This study included 15 male subjects and 15 female subjects between 25 and 45 years of age without any clinical complaints and manifestations, who have been exercising regularly for at least a year. Age-matched individuals who had not been exercising regularly were included as the control group. Subjects orally received 20 grams of freshly ground linseed daily on an empty stomach in the morning, 30 minutes before the breakfast for 12 weeks. Blood samples were drawn into biochemistry and hemogram tubes at the start and end of the trial. The following parameters were investigated on these samples: glucose, urea, creatine, cholesterol, triglyceride, high density lipoprotein (HDL), aspartate aminotransferase (AST), alanine aminotranferase (ALT), Gamma-glutamyl transpeptidase (GGT), Alkaline phosphatase (ALP), creatine kinase (CK), creatine kinase *MB* (CK-MB), lactate dehydrogenase (LDH), uric acid, calcium (Ca), iron (Fe) and haemogram. The cases were also monitored for blood pressure and body weight.

**Results**: Changes in ALP, CK, Ca, Fe, red blood cell (RBC) and weight were significant of males who did not exercise ($p<0.05$, $p<0.01$). The males who exercised regularly exhibited significant changes in urea, cholesterol, triglyceride, HDL, AST, ALT, LDH, Fe, haemoglobin (HGB), haematocrit (HCT), mean corpuscular hemoglobin concentration (MCHC), platelet distrubition width

(PDV) and weight ($p<0.05$, $p<0.01$). Females who did not exercise had significant changes in glucose, HDL, ALP, CK, CK-MB and uric acid, RBC and HCT ($p<0.01$). Females who exercised regularly exhibited significant changes in glucose, cholesterol, triglyceride, HDL, AST, ALP, CK, LDH, Ca, Fe, RBC, HGB, lymphocyte (LYM) and diastolic blood pressure ($p<0.05$, $p<0.01$).
**Conclusion**: Regular exercise and linseed consumption have a favorable impact on the lipid metabolism and regulate blood pressure. The absence of elevations in the hepatic and renal enzymes suggests that linseed is not toxic for the organism. The fact that some of the biochemical and hematologic parameters are in line with data reported in the literature while some exhibit differences relative to the data underlines the necessity of supporting these results on exercise combined with linseed consumption with future trials.

**Keywords**: Exercise, Linseed, Blood pressure, Laboratory parameters.

## INTRODUCTION

The term "health behaviour" is generally used to describe individuals' attitudes towards protecting their health and how they react when they have healthcare issues. People exhibit certain behaviors in protecting their health, which result from various personal and social factors. Those who exhibit all or some of these health-protecting behaviors were detected to be healthier than those who do not[1]. Adopting habits that increase quality of life and regular exercise are important for staying healthy as age increases. Trials have demonstrated the favorable effects of exercise on the human organism[2,3]. In a study performed on females between 15 and 21 years of age, the results revealed that good health could be maintained by a healthy diet, exercise and by avoiding behavior that is harmful for the body[4].

Exercise has gained significance in daily life due to factors including developing economic conditions, industrialization, intense urbanization, increased free time, and individual health-related concerns. In addition to the exercise done for performance purposes, exercise done for a healthy life, in other words for increasing the quality of life, is becoming increasingly popular[5].

Regular exercise eliminates a significant portion of the risk factors involved in the development of coronary artery disease (CAD)[6]. Regular exercise decreases the risk of CAD events by inducing an increase in fibrinolysis, a reduction in the predisposition to thrombosis and improvements in endothelial functions. Regular exercise also has favorable effects on the structure of the blood, blood pressure, blood lipid and protein levels, and cardiac-respiratory concordance as well as the effects on cardiovascular diseases[7].

People seek solutions when they have health issues. This solution seeking involves different methods ranging from modern to conventional medicine. Regarding the protection of health and the

solution of the healthcare issues, consulting methods other than modern medicine is increasing recently in the developed countries[8,9]. These methods are generally referred to as complementary or alternative medicine. One such remedy is linseed[10].

Linum (*Linum usitatissimum*) is a one-year cultivated plant of 30-100 cm length with blue flowers used for various purposes, which has been planted since the ancient Egyptian times. The seeds are of 4 to 6-mm length, egg-shaped, flat, bright, dark reddish, odorless, oily and tasty[11]. Linseed flour and oil has been used as food in Asia, Europe and Africa for centuries. Linseed contains three major components that are significant for human nutrition. These include alpha linoleic acid (omega-3 fatty acid), and highly soluble and insoluble fibers and plant lignans (plant estrogen)[12]. Linseed also contains soluble polysaccharides, proteins, vitamins (vitamin A, E, C and B12) and minerals (a high level of K, low levels of Mg, Fe, Cu and Zn)[13,14].

Studies on linseed report that regular consumption of linseed results in a decreased risk a coronary heart disease due to the regular intake of alpha linoleic acid (ALA); potentially prevents vascular coagulation leading to heart attack or thrombosis, and the development of atherosclerosis; potentially indicates favorable effects in inflammatory and autoimmune diseases[15,16,17]; and it can prevent cancer owing to its lignan and vitamin E components with anti-cancer and antioxidant characteristics[18].

As with every plant, an unbalanced intake of linseed may lead to undesirable effects. FDA (Food and Drug Administration) allows linseed content of up to 12% in foods[19]. The potential adverse effect of the nutritional components in linseed is related to the high amount of multiple unsaturated fatty acids. The large number of double bonds renders these fatty acids suitable for oxidation and free fatty acid formation. Therefore, a high amount of linseed taken over the long-term through diet increases oxidative stress and potentially reduces antioxidant compounds. In trials, mice fed on a diet containing 20% linseed were observed to have a reduced plasma and liver vitamin E content[20]. Trials report that the phytic acid present in the linseed binds to positively-charged minerals, such as zinc and calcium, leading to a deficiency of these minerals and the affecting of bone development[21]; linatine, an anti-nutritional compound, known to bind to vitamin B6 could lead to B6 vitamin deficiency and thus an increase in homocysteine and renal deficiency; consumption of a high amount of uncooked linseed could also lead to the production of cyanogenic glycosides (HCN), which are potentially toxic for the body[19,21].

Based on literature screening, we conclude that regular exercise and appropriate doses of linseed have favorable effects on the organism. This trial was designed to investigate the effects of linseed, a plant commonly used by the public, on certain blood parameters in healthy individuals who do and do not exercise regularly.

## MATERIAS AND METHOD

This trial included 15 male subjects and 15 female subjects between 25 and 45 years of age without any clinical complaints or manifestations, who have been exercising regularly (at a commercial gym) for at least a year (1 hour, 3 days per week). Age-matched individuals who have not been exercising regularly were included as the control group. Subjects orally received 20 grams of freshly ground linseed daily on an empty stomach in the morning, 30 minutes before the breakfast for 12 weeks. Blood samples were drawn at the start and end of the trial. The following biochemical and hematological parameters

were investigated on these samples, respectively: glucose, urea, creatine, cholesterol, triglyceride, HDL, AST, ALT, GGT, ALP, CK, CK-MB, LDH, uric acid, Ca, Fe, iron binding capacity; and white blood cell (WBC), RBC, HGB, HCT, mean corpuscular volume (MCV), MCHC, PDV, platelet (PLT), LYM, neutrophil, red cell distribution width (RDW), mean platelet volume (MPV); blood pressure and weight changes were also assessed.

### Statistical Analysis

Statistical analyses were performed by using the MINITAB software. For the analyses, first the descriptive statistics of the investigated variables were calculated. Subsequently, the pre-procedure and post-procedure values for the investigated parameters both for males and females were subject to the paired t-test.

## RESULTS

The trial was conducted in a total of four groups, each containing 15 individuals to give a total subject number of 60. The descriptive statistical results for certain biochemical parameters, hematological parameters and blood pressure and weight changes obtained in healthy males who do not exercise regularly are presented in Tables 1, 2 and 3, respectively; the same parameters obtained in males who exercise regularly are presented in Tables 4, 5 and 6; the results for healthy females who do not exercise regularly are presented in Tables 7, 8 and 9 while the results for females who exercise regularly are given in Tables 10, 11 and 12. In addition, the descriptive statistics for the age variability between males and females are presented in Table 13.

Males using linseed without regular exercise exhibited no significant changes from day 0 to week 12 in the biochemical parameters of blood glucose, urea, creatine, cholesterol, triglyceride, HDL cholesterol, ALT, AST, GGT, CK-MB, LDH and uric acid levels ($p>0.05$) while the changes in ALP, CK, Ca and Fe were statistically significant ($p<0.01$, $p\leq0.05$, ($p<0.01$, $p<0.01$, respectively). While there was no significant change in the hematological parameters of white blood cell (WBC), HGB, HCT, MCV, MCHC, PDV, PLT, LYM, neutrophil, RDW-SD, RDW-CV and MPW ($p>0.05$), the change in the RBC level was significant ($p<0.05$). The change in weight from day 0 to day 90 was significant ($p<0.01$) while the change in the diastolic blood pressure was not ($p>0.05$). Males using linseed with regular exercise exhibited no significant changes from day 0 to week 12 in the biochemical parameters of blood glucose, creatine, ALP, CK, CK-MB, uric acid and Ca levels ($p>0.05$). The changes in Urea ($p\leq0.05$), cholesterol ($p<0.01$), triglyceride ($p<0.01$), HDL ($p<0.01$), AST ($p\leq0.01$), ALT ($p<0.01$), LDH ($p\leq0.05$) and Fe ($p\leq0.01$) were statistically significant. While the hematological parameters of WBC, RBC, MCV, PLT, LYM, neutrophil, RDW-SD, RDW-CV and MPV exhibited no significant change ($p>0.05$), the changes in HGB ($p<0.05$), HCT ($p\leq0.01$), MCHC ($p<0.05$), PDV ($p<0.05$) were significant. The change in body weight from Day 0 to week 12 was significant ($p<0.01$) while the changes in the systolic and diastolic blood pressure were not ($p>0.05$). The healthy females using linseed without regular exercise exhibited no significant changes from day 0 to week 12 in the biochemical parameters of blood urea, creatine, cholesterol, triglyceride, ALT, AST, GGT, LDH, Ca and Fe levels ($p>0.05$). The changes in glucose ($p<0.01$), HDL ($p<0.05$), ALP ($p\leq0.01$), CK ($p<0.01$), CK-MB ($p<0.01$) and uric acid ($p<0.05$) were statistically significant. While there were no significant changes in the hematological parameters of WBC, HGB, MCV, MCHC, PDV, PLT, LYM, neutrophil, RDW-SD, RDW-CV and MPV levels ($p>0.05$), the

changes in RBC ($p<0.05$) and HCT ($p<0.05$) were significant. The change in weight and blood pressure from Day 0 to week 12 was not significant ($p>0.05$). The females using linseed with regular exercise exhibited no significant changes from day 0 to week 12 in the biochemical parameters of blood urea, creatine, ALT, GGT, CK-MB and uric acid levels ($p>0.05$).The changes in glucose ($p\leq0.01$), cholesterol ($p<0.01$), triglyceride ($p<0.01$), HDL ($p<0.01$), AST ($p<0.05$), ALP ($p\leq0.01$), CK($p\leq0.01$), LDH ($p<0.01$), Ca ($p<0.05$) and Fe ($p<0.01$) were statistically significant. While there was no significant change in the hematological parameters of WBC, HCT, MCV, MCHC, PDV, PLT, neutrophil, RDW-SD, RDW-CV and MPV ($p>0.05$), the change in RBC ($p<0.01$), HGB ($p<0.05$) and LYM ($p<0.05$) was significant. The change in weight and systolic blood pressure from day 0 to week 12 was not statistically significant ($p>0.05$), while the change in diastolic blood pressure was significant ($p<0.05$). The age difference between males and females who do and do not exercise was not statistically significant ($p>0.05$).

## DISCUSSION AND CONCLUSION

This trial investigated the effects of linseed on blood pressure, serum lipids, the hematopoietic system, and liver and kidney tests in males and females who do and do not exercise. In general, trials report the favorable effects of regular exercise on peripheral blood cells (erythrocytes, leukocytes, platelets)[22,23]. In addition to its favorable impact on the functions of the body, the unfavorable effects of acute exercise on blood circulation were also demonstrated to be characterized by an increase in post-exercise hematocrit value, blood flow rate, plasma viscosity and erythrocyte rigidity and reduction in sedimentation[24]. Additionally, various trials report the favorable impact of exercise training on the lipid and carbohydrate metabolism, mild reductions in body weight, fat stores, total cholesterol and serum triglycerides and LDL cholesterol and increases in antiatherogenic HDL cholesterol provided by exercise, and that these improvements could lead to significant effects on cardiovascular risk[25,26]. Thus, exercise is beneficial if it is continued for a long period of time[27].

Recently, the increasing will to reduce the risk of disease and live a healthy life, and the improved consciousness of healthy nutrition increasingly lead to a tendency to use herbal products. Health authorities recommend diets rich in cereals, fresh vegetables and fruits containing a reduced amount of animal meat and fats. Evaluating linseed in this respect, it is rich in α-linolenic acid and high-quality protein and also contains phytochemicals, such as flavonoids, lignans and phenolic acids[11,28]. In the trial by Bieranbaum *et al*[29], 15 hyperglycemic patients received 15 grams of linseed and 800 IU/g vitamin E daily for three months and exhibited a significant reduction in serum total cholesterol, LDL cholesterol and serum lipid oxidation products while HDL cholesterol did not change at all.

The results from the trial performed by Harper *et al*[30] on 56 subjects, of which 31 received linseed capsules and the remaining 25 received placebo capsules containing olive oil, demonstrated a 25% increase in the plasma values of docosapentaenoic acid (DPA), a cardioprotective fatty acid, in the linseed group, while the olive oil group showed no changes.

In a trial by Stuglin and Prasad[31], males between 22 and 27 years of age were administered 32grams of linseed daily for four weeks to investigate whether long-term use of linseed could be harmful to these individuals and to observe the changes it could potentially induce in blood pressure, and biochemical and hematological parameters. The results from this trial

demonstrated no harmful effects of long-term linseed use on the liver, kidneys and hematopoietic system and that linseed did not change the levels of blood pressure, serum lipids, hemoglobin level, red and white blood cells, neutrophil levels, serum totals cholesterol, HDL-C, LDL-C and VLDL C, serum total bilirubin, AST, ALP, protein, albumin, glucose and urea; however, it increased serum triglyceride levels and decreased serum creatine levels. Bhathena *et al*[32] reported that linseed decreased blood cholesterol, triglyceride, uric acid and BUN levels while Lemay *et al*[33] reported that linseed decreased blood glucose levels.

While there was no significant change in the blood glucose level in males who do and do not exercise ($p>0.05$), females who do ($p\leq0.01$) and do not exercise ($p<0.01$) exhibit a significant reduction in blood glucose level ($p<0.01$) at the end of 12 weeks. The glucose levels obtained in males are in line with the results from Stuglin and Prasad[31] and the glucose levels obtained in females are in line with the results from Lemay *et al*[33].

The differences in results between the two genders may result from a metabolism difference between males and females or a change in the dietary regimen.

While a significant reduction was observed in the blood urea levels after 12 weeks in males who exercise regularly ($p\leq0.05$), no such significant change was detected in females who exercise regularly ($p>0.05$). Among males and females who do not exercise regularly, there was no significant change in the results between day 0 and week 12.

Creatinine plays a significant role in the creatine-phosphate type muscle contraction[34]. Serum creatinine level increases in patients with renal failure and renal arterial stenosis[35]. Among males and females who do and do not exercise, there was no significant change in blood creatine levels in the 12-week period ($p>0.05$). These results support the idea that linseed has no unfavorable effects on the kidney in individuals using linseed. Cholesterol both includes the free cholesterol and the cholesterol esters. The measurement of the two is expressed as the total cholesterol[35]. HDL cholesterol is synthesized both in the liver and the intestines; its main function involves transport of cholesterol from the tissues to the liver. This process is called the reverse cholesterol transport. There is a reverse correlation between the development of coronary cardiac diseases and HDL[36]. While significant reductions are detected in the blood cholesterol level in males and females who exercised ($p<0.01$), the change in males and females who did not exercise was not statistically significant ($p>0.05$). While the HDL cholesterol level ($p<0.01$) increased significantly in females who did not exercise ($p<0.05$), the increase in males who did not exercise was not significant ($p>0.05$). In particular, the increase in HDL cholesterol in all the groups suggests the favorable effect of linseed.

While the blood triglyceride level showed a significant decrease in males and females who exercised in this trial ($p<0.01$), the changes in males and females who did not exercise was not statistically significant ($p>0.05$). These results suggest that the reduction in the blood triglyceride level may result from the exercise rather than the linseed; whereas, Stuglin and Prasad[31] suggested that the linseed increased the triglyceride level while Bhathena *et al*[32] reported a reduction in triglyceride induced by the linseed. Therefore, given these results on the triglyceride levels, future trials are required on exercise and linseed.

Serum ALT and AST levels, which represent the most commonly used tests in the diagnosis of liver diseases, are elevated before the onset of clinical manifestations. Serum GGT levels are investigated for assessing obstructive liver diseases[35]. In all liver

diseases involving hepatic cell damage, transaminase levels exhibit an increase. While AST (SGOT) is present both in mitochondria and cytoplasm, ALT (SGPT) is only present in the cytoplasm. In mild cellular damage, ALT levels are increased more relative to AST levels. As for cases involving cellular damage and necrosis, the AST increase is higher[36]. The increase in ALP activity may be the natural result of biliary damage, liver damage, steroids and some other drugs, diffuse bone diseases, certain neoplasias or endocrine diseases. The importance of a low activity of these enzymes is not known[37]. In this trial, there were significant reductions in the ALT and AST enzyme activities from day 0 to week 12 ($p<0.001$ and $p\leq0.01$, respectively) in exercising males, while the non-exercising males exhibited insignificant changes in enzyme activity ($p>0.05$). GGT levels showed statistically insignificant changes in exercising and non-exercising males. While the ALT and GGT activity changes were statistically insignificant in exercising and non-exercising females ($p>0.05$), the mild increases in the AST activity observed in exercising females were statistically significant ($p<0.05$) and insignificant in non-exercising females ($p>0.05$). Mert[37] reported that a mild reduction in these enzyme levels is not important. While there was no statistical significance in the ALP enzyme levels in exercising males ($p>0.05$), the non-exercising males exhibited significant reductions ($p<0.01$).

The exercising and non-exercising females exhibited statistically significant elevations in ALP activity ($p\leq0.01$). Particularly, the increase in ALP observed both in exercising and non-exercising females is of interest and needs to be further elucidated by future trials. CK has three isoenzymes in the skeletal muscle, cardiac muscle and the brain. CK and CK-MB, representing clinical significance upon increase, are commonly used in diagnosing skeletal muscle disorders and myocardial infarction (MI)[36,38]. While the change in CK levels was insignificant in exercising males ($p>0.05$), it was significantly high in non-exercising males ($\leq0.05$).

The exercising and non-exercising females exhibited significant increases in the CK level ($p\leq0.01$ and $p<0.01$, respectively). While there were no statistically significant changes in the CK-MB level in exercising and non-exercising males and exercising females ($p>0.05$), the non-exercising females had significant reductions ($p<0.01$). Adam[38] reported similar elevations in CK and CK-MB in case of MI. Particularly, the increase in CK with the decrease in CK-MB observed in non-exercising females seems to be contradictory. Future trials are required to elucidate this. LDH involves five enzymes, which are present in various body tissues, and particularly in the skeletal muscle, cardiac muscle, liver, erythrocyte, kidneys, pancreas, bones and the lungs. Elevations may occur in the disorders of the skeletal muscle, cardiac muscle and the liver. The total LDH level is sensitive but not specific[37,38]. In this trial, while the increase in the LDH level was significant in exercising males ($p\leq0.05$), it was not in non-exercising males ($p>0.05$). The non-exercising females exhibited an insignificant change in LDH ($p>0.05$) while the exercising females had significantly low levels ($p<0.01$).

In this trial, statistically insignificant changes were observed in serum uric acid levels in exercising and non-exercising males ($p>0.05$). While exercising females exhibited statistically insignificant uric acid changes ($p>0.05$), non-exercising females ($p<0.05$) showed significant changes.

The change in Ca level was statistically insignificant in exercising males and non-exercising females ($p>0.05$). In non-exercising males and exercising females, Ca levels showed significant changes at the end

of 12 weeks ($p<0.01$ and $p<0.05$, respectively). While there were significant reductions in the Fe level in exercising males ($p\leq0.01$), non-exercising males ($p<0.01$) and exercising females ($p<0.01$), non-exercising females exhibited no statistically significant changes ($p>0.05$).

Depending on the type, intensity and duration of the exercise, there may be variability in the hematological parameters. The hematological parameters may show variability during and after exercise due to the training status of the individual, the gender, age, environmental factors and nutrition. Due to long term exercise, sportsmen exhibit hematological changes[39]. There are many trials investigating the effects of exercise on hematological parameters. In fact, as the blood parameters affect the type and intensity of the exercise, the exercise also affects the blood parameters and is of significance with respect to various blood pathologies[40].

Prasad[41] reported the following in relation to his investigation on the effects of chronic administration of lignan complex isolated from linseed on the hematopoietic system of rabbits: lignan complex administered at a dose of 40 mg/kg daily for two months resulted in no change in blood MCV, RDW, Hct, Hb, MCH, MCHC, and platelet volume values, and thus lignan compounds have no adverse effects on the hematopoietic system. In the trials investigating the effect of exercise on the WBC values, Yeh *et al*[42] and Banfi *et al*[43] reported no difference between the pre-exercise and post-exercise WBC values. In the trial, the results revealed no statistically significant change in WBC levels due to linseed consumption in exercising and non-exercising males and females ($p>0.05$). The results are in line with the literature data[34,42,43]. These results suggest that the linseed does not affect WBC levels.

In sportsmen on an intense exercise program, Hb and Hct values are reduced characteristically, a condition considered as sportsman anemia[44]. In particular, a mild reduction in blood volume is observed during exercises as a result of dehydration. Blood volume may change during conditions where dehydration is high. In this trial, the increases in HGB were significant in exercising males and females ($p<0.05$) while they were insignificant in the other two groups ($p>0.05$). While the increases in HCT levels were statistically significant in exercising males and non-exercising females ($p<0.05$), the other two groups exhibited no statistical significance ($p>0.05$). Our results are not in line with the literature data with respect to exercise. This difference may be attributed to the linseed administration.

Trials report increases in the RBC levels during various degrees of exercise intensity[45,46] and that sportsmen have higher RBC levels relative to sedentary individuals[47]. In this trial, RBC levels showed an increase in all the groups; the level of statistical significance was $p<0.05$ in non-exercising males and females and $p<0.01$ in exercising females.

In a trial by Unal *et al*[44], no significant change was reported in the PLT values after eight weeks of chronic aerobic exercise ($p>0.05$). Similarly, Büyükyazı *et al*[48] reported no significant change in the PLT levels in the sedentary subjects after chronic exercise ($p>0.05$). This trial detected no statistically significant change in blood PLT levels in exercising and non-exercising males and females using linseed ($p>0.05$). Our results are in line with the literature data[44,48].

In this trial, no statistically significant changes were observed in the neutrophil, RDW-SD, RDW-CV and MPV levels in exercising and non-exercising males and females ($p>0.05$). These results are in line with the results of Prasad[40]. While MCHC and PDV levels showed a significant change in exercising males ($p<0.05$), the other three groups exhibited no significance ($p>0.05$).

While LYM levels increased in all groups, the increase in exercising females was statistically significant ($p<0.05$).

While there were statistically significant reductions in body weight from day 0 to week 12 in exercising and non-exercising males using linseed ($p<0.01$), the change was not statistically significant in females ($p>0.05$).

The exercising and non-exercising males and females using linseed exhibited no statistically significant change in systolic blood pressure from day 0 to week 12 ($p>0.05$), while the diastolic blood pressure showed significant reductions in exercising females only ($p>0.05$). The difference between the age of the subjects was considered statistically insignificant for all groups ($p>0.05$).

In conclusion, these results demonstrate that regular exercise and linseed consumption regulate blood pressure and affect lipid metabolism. The absence of any increases in liver and kidney enzymes suggests that linseed is not toxic for the organism. The fact that some of the biochemical and hematologic parameters are in line with data reported in the literature while some exhibit differences relative to the data underlines the necessity of supporting these results on exercise combined with linseed consumption with future trials.

## REFERENCES


1. Belloc NB, Breslow L. Relationship of physical health status and health practices. Preventive Medicine. 1972; 1 (3): 409-421.
2. Demir M, Filiz K, 2004. Spor egzersizlerinin insan organizması üzerindeki etkileri, Gazi Üniversitesi Kırşehir Eğitim Fakültesi, Cilt 5, Sayı 2, 109-114
3. Johnson PH, Kittleson MJ. A qualitative exploration of health behaviors and the associated factor among university students from different cultures. *The International Electronic Journal of Health Education*. 2003; 6: 14-25. http://www.iejhe.org.
4. Stevens CA. Being healthy: Voices of adolescent women who are parenting, *Journal for Specialists in Pediatric Nursing*. 2006; 11 (1): 28-40.
5. Morgan PM, Roberts JA and Feinerman AD., 1971. Psychological effect of acute physical activity, Archives of Physical Medicine @ Rehabilitation, 52, 422-425.
6. Wannamethee S.G, Lowe G.D, Whincup P.H, *et al*. Physical activity and hemostatik and inflammatory variables in elderly men. Circulation. 2002;105. 1785–1790.
7. Thomas N.E, Baker J. S, Davies B. Established and recently identified coronary heard disease risk factors in young people, the influence of physical activity and physical fitness. Sport Med. 2003; 33. 633–650.
8. Tindle HA, Davis RB, Phillips RS, Eisenberg DM. Trends in use of complementary and alternative medicine by US adults: 1997-2002. Alternative Therapies in Health and Medicine. 2005; 11: 42-49.
9. Furnham A. Complementary and Alternative Medicine. Psychologist. 2002; 15: 228-231.
10. İşleroğlu H, Yıldırım Z ve Yıldırım M, 2005. Fonksiyonel Bir Gıda Olarak Keten Tohumu, GOÜ. Ziraat Fakültesi Dergisi, 22 (2), 23-30.
11. Mazza, G. 1998. Flaxseed Products For Disease Prevention. In: Functional Foods, Biochemical and Processing Aspects, Lancaster, Pennsylvania: Technomic Publishing Company, 91-127.
12. Lay, C., Dybing, D., 1989. Linseed in oil crops of the world. In: Robbelen,G., Downey, R., Ashri, A. (Eds.). Mc Graw Hill, New York, pp. 121–129.
13. Klotzabach-Shimomura, K., 2001. Functional Foods: The Role of Physiologically Active Compounds in Relation to Disease. Topics in Chinical Nutrition, Mar.
14. Chung, M.W.Y., Lei, B. and Li-Chan, E.C.Y., 2005. Isolation and Structural Characterizaion of The major Protein Frction From Nor Man Flaxseed (*Linum usitatissimum* L.). Food Chemistry, 90, 271-279.
15. Chan J.K., Bruce V.M., Mc Donald B., 1991.Dietary a-Linolenic Acid is as

Effective as Oleic Acid and Linoleic Acid in Lowering Blood Cholesterol in Normolipidemic Men. *Am J Clin Nutr*, 53:1230–4.
16. Lorgeril D.M., Renaud S., Maelle N., 1994. Mediterranean Alpha-Linolenic Acid-Rich Diet in Secondary Prevention of Coronary Heart Disease. Lancet, 343:1454–9.
17. Serraino M., 1991. The Effects of Flaxseed Supplementation on Early Risk Markers for Mammary Carcinogenesis. Cancer Letter, November.
18. Brooks J. D., Ward W.E., Lewis J.E., Hilditch J., Nickell L., Wong E., Thompson L.U., 2004. Supplementation with flaxseed Alters Estrogen Metabolism in Postmenopausal Women to a Greater Extent than does Supplementation with an Equal Amount of Soy. *American Journal of Clinical Nutrition*, 79(2): 318-325.
19. Bloedon, L. T. and Szapary, O.P. 2004. Flaxseed and Cardiovascular Risk. Nutrition Reviews, 62, 18-27.
20. Javouhey-Donzel, A., Guenot, L., Maupoll, V., Rochette, L., and Rocquelin, G., 1993. Rat Vitamin E Status and Heart Lipid Peroxidation: Effect Of Dietary A-Linolenic Acid And Marine N-3 Fatty Acids. Lipids, 28, 651-655.
21. Wiesenfeld, P. W., Babu, U. S., Collins, T. F. X., Sprando, R., O'Donnell, M. W., Flynn, T. J., Black, T., Olejnik, N. 2003. Flaxseed Increased A-Linolenic And Eicosapentaenoic Acid And Decreased Arachidonic Acid İn Serum And Tissues Of Rat Dams And Offspring. *Food and Chemical Toxicology,* 41, 841-855.
22. Hack B, Strobel G, Weiss B, and weicker H. PMN cell count and phagocytic activity of higly trained athletes depend on training period. *J. Appl Physiol*. 1994;77. 1731–1735.
23. Mackınnon L.T, Hoper S, Jones S, Gordon R.D, Bachmann A.W. Hormonal, immunological, and hematological responses to intensified training in elite swimmers. *Med. Sci. Sports Exerc*. 1997;29. 1637–1645.
24. Ajmani R.S, Fleg J.L, Demehin A, *et al*. Oxidative stress and hemorheological changes induced by acute treadmill exercise. Clin Hemorheol Microcirc. 2003; 28. 29–40.
25. Tran Z.V., Weltman A. Differential effects of exercise on serumlipid and lipoprotein levels seen with changes in body weight: a meta-analysis. *JAMA* 1985; 254:919-24.
26. La Monte M.J., Durstine J.L., Addy C.L., Irwin M.L., Ainsworth B.E. Physical activity, physical fitness, and Framingham 10-year risk score: cross-cultural activity participation study. *J Cardiopulm Rehabil* 2001; 21:63.
27. Yalın S, Gök H ve Telli H.H. Düzenli egzersiz ve fibrinojen. *T Klin J Cardiol* 2001; 14: 338-344.
28. Korthals, M. 2002. The Struggle Over Functional Foods: Justice And The Social Meaning Of Functional Foods. *Journal of Agricultural and Environmental Ethics*, 15, 315-324.
29. Bierenbaum M.L., Reichstein R., Watkins TR. Reducing atherogenic risk in hyperlipidemic humans with flax seed supplementation: a preliminary report. *J Am Coll Nutr*. 1993 Oct; 12(5): 501-4.
30. Harper C.R., Edwards M.J., DeFilipis A.P., Jacobson T.A. Flaxseed oil increases the plasma concentrations of cardioprotective (n-3) fatty acids in humans. *J. Nutr*. 2006 Jan; 136 (1): 83-7.
31. Stuglin C., Prasad K. Effect of flaxseed consumption on blood pressure, serumlipids, hemopoietic system and liver and kidney enzymes in healthy humans. *J. Cardiovasc Pharmacol Ther*. 2005 Mar; 10 (1): 23-7.
32. Bhathena S.J., Ali A.A., Mohamed A.I., Hansen C.T., Velasquez M.T. Differential effects of dietary flaxseed protein and soy protein on plasma triglyceride and uric acid levels in animal models. *The Journal of Nutritional Biochemistry,* Volume 13, Issue 11, Pages 684-689.
33. Lemay A, Dodin S, Kadri N, Jacques H, Forest JC. Flaxseed dietary supplement versus hormone replacement therapy in hypercholesterolemic menopausal women. Obstet Gynecol. 2002 Sep;100(3):495-504
34. Mehmetoğlu İ (2004). Klinik Biyokimya Laboratuarı El Kitabı. Yelken Basım – Yayım – Dağıtım, Yelken Ajans, ISBN : 975 – 92558 – 0 – 4, 271 – 272.
35. Turgut K (2000). Lipid Bozuklukları, Veteriner Klinik Laboratuar Teşhis Kitabı,

Bahcıvanlar Basım Sanayi A.Ş., ISBN 975-94595-1-5, S. 472-487.
36. Laker MF (1996). Clinical biochemistry for medical student, Departman of Clinical Biochemistry and Metabolic Medicine, The Medical School, University of Newcastle upon Tyne ‘‘Çeviren’’ Ulukaya E, Tokulllugil HA, Gür E (1996). Tümör markırları, Klinik Biyokimya, Sayfa 245.
37. Mert N. Enzimler. Veteriner Klinik Biyokimya Kitabı, Uludağ Üniversitesi Güçlendirme Vakfı Yayınları, ISBN 975-564-050-9, Ceylan Matbaacılık, 230-246, 1997.
38. Adam B, Göker Z and Ardıçoğlu Y (2003). Tümör belirteçlerinin klinik tanıdaki önemi. Temel – Klinik Biyokimya Ders Kitabı, Atlas Kitapçılık Tic. Ltd. Şti.
39. Beydağı, H., Çoksevim, B., Temoçin, S., Spor yapan ve yapmayan gruplarda bazı eritrositer parametrelere egzersizin etkisi, Gaziantep Üniversitesi Tıp Fak Derg, 5, 21 – 28, 1994.
40. Çavuşoğlu, H., Egzersiz ve kan, İstanbul Tıp Fakültesi 11. Kurultayı Bidiri Kitabı, 249 – 252, 1991.
41. Prasad K. Effect of flaxseed consumption on blood pressure, serum lipids, hemopoietic system and liver and kidney enzymes in healthy humans. *J Cardiovasc Pharmacol Ther*. 2005 Mar;10(1):23-7.
42. Yeh S-H, Chuang H , Lin L-W , Hsiao C-Y , Eng H L ; Regular Tai Chi Chuan Exercise Enhances Functional Mobility And Cd4cd25 Regulatory T Cells *British Journal of Sports Medicine*;40:239-243; 2006.
43. Banfi G,Del Fablo M,Mauri C,Corsi Mm, Melegati G,*et al*, Hematological Parameters İn Higly Elite Rugby Players During A Competitive Season. Jun Pub Med –İndexed For Medline, 28( 3):183-8, 2006
44. Ünal, M., Aerobik ve Anaerobik Akut-Kronik Egzersizlerin Immun Parametreler Üzerindeki Etkileri, İ.Ü. Sağlık Bilimleri Enstitüsü, 20, İstanbul, 1998.
45. Zergeroğlu Am, Ersöz G, Yavuzer S; Sedanter Erkeklerde Supramaksimal Ve Basamaklı Egzersizlerde Eritrosit Antioksidan Enzim Aktivitesi. Spor Hek. Der, 34, 65-71. 1999
46. Ercan M, Bayıroğlu F, Kale R, Adak B, Tuncer İ, Tekeoğlu İ, *et al*, Uzun Süreli Dayanıklılık Koşusu Kategorisinde Gerçekleştirilen Bir Egzersizin Bazı Kan Parametrelerine Etkisi. Spor Hek. Der, 31, 73-80. 1996
47. Nıkolaıdıs M. G, Protosygellou M. D, Petrıdou A, Tsalıs G, Tsıgılıs N., Mougıos V.,*et al*,;Hematologic And Biochemical Profile Of Juvenile And Adult Athletes Of Both Sexes: Implications For Clinical Evaluation *International Journal of Sports Medicine*, Vol. 24, No7, Pp. 506-511 [6 Page(S) (Article)] (27 Ref.) 2003.
48. Büyükyazı G, Karadeniz G, Kutlu N, Çabuk M, Ceylan C, Özdemir E Ve Seven S,*et al*, Kronik Antrenmanın Yaşlılarda Serum Demir, Magnezyum, Hematolojik Ve Lipit Parametreleri Üzerine Etkisi. Spor Hek. Der, ,37,51-59.2002.

**Table 1.** The change in certain biochemical parameters in non-exercising males

| Biochemical Parameters | n | 0. Day Mean + St Dev | 12. Week Mean + St Dev | P |
|---|---|---|---|---|
| Glucose (mg/dl) | 15 | 101.98 ± 23.01 | 91.67 ± 11.18 | P>0.05 |
| Urea (mg/dl) | 15 | 26.66 ± 8.66 | 26.13 ± 11.44 | P>0.05 |
| Creatine (mg/dl) | 15 | 0.952 ± 0.342 | 0.822 ± 0.192 | P>0.05 |
| Cholesterol (mg/dl) | 15 | 174.1 ± 44.0 | 191.1 ± 41.0 | P>0.05 |
| Triglyceride (mg/dl) | 15 | 159.9 ± 120.9 | 185.3 ± 98.1 | P>0.05 |
| HDL (mg/dl) | 15 | 44.79 ± 12.87 | 50.48 ± 9.46 | P>0.05 |
| AST (U/L) | 15 | 18.71 ± 10.07 | 23.54 ± 9.37 | P>0.05 |
| ALT (U/L) | 15 | 27.79 ± 10.96 | 27.53 ± 15.19 | P>0.05 |
| GGT (U/L) | 15 | 30.07 ± 29.72 | 17.37 ± 5.12 | P>0.05 |
| ALP (U/L) | 15 | 149.1± 17.0 | 106.4 ± 53.8 | P<0.01 |
| CK (U/L) | 15 | 108.9 ± 41.1 | 181.4 ± 108.5 | P≤0.05 |
| CK-MB (U/L) | 15 | 15.32 ± 3.04 | 18.07 ± 7.82 | P>0.05 |
| LDH (U/L) | 15 | 261.6 ± 47.5 | 297.6 ± 122.8 | P>0.05 |
| Uric Acid (mg/dl) | 15 | 3.721 ± 1.319 | 3.874 ± 2.725 | P>0.05 |
| Ca (mg/dl) | 15 | 8.630 ± 0.532 | 9.55 ± 1.01 | P<0.01 |
| Fe (ug/dl) | 15 | 83.00 ± 11.33 | 64.60 ± 17.22 | P<0.01 |

*Abbreviations for biochemical parameters: HDL (high density lipoprotein), AST (aspartate aminotransferase), ALT (alanine aminotranferase) GGT (gamma-glutamyl transpeptidase), ALP (alkaline phosphatase), CK (creatine kinase), CK-MB (creatine kinase MB), LDH (lactate dehydrogenase), Ca (calcium), Fe (iron).

**Table 2.** The change in certain hematological parameters in non-exercising males

| *Haematological parameters* | n | 0. Day Mean + St Dev | 12. Week Mean + St Dev | P |
|---|---|---|---|---|
| WBC (fL) | 15 | 7.86 ± 0.86 | 7.92 ± 1.01 | P>0.05 |
| RBC (million/$mm^3$) | 15 | 5.03 ± 0.46 | 5.39 ± 0.67 | P<0.05 |
| HGB (gr/dl) | 15 | 14.87 ± 1.22 | 14.83 ± 1.52 | P>0.05 |
| HCT (%) | 15 | 44.72 ± 3.18 | 45.00 ± 2.79 | P>0.05 |
| MCV ($\mu m^3$) | 15 | 89.03 ± 4.23 | 89.76 ± 4.55 | P>0.05 |
| MCHC (gr/dl) | 15 | 33.90 ± 1.26 | 34.48 ± 1.48 | P>0.05 |
| PDV (%) | 15 | 14.22 ± 1.15 | 14.10 ± 1.55 | P>0.05 |
| PLT (/$mm^3$) | 15 | 282.90 ± 30.33 | 277.10 ± 24.00 | P>0.05 |
| LYM (/$mm^3$) | 15 | 28.86 ± 4.50 | 29.36 ± 4.67 | P>0.05 |
| NEUTROPHIL (/$mm^3$) | 15 | 58.00 ± 21.71 | 63.54 ± 15.45 | P>0.05 |
| RDW-SD (%) | 15 | 47.17 ± 4.88 | 47.65 ± 5.40 | P>0.05 |
| RDW-CV (%) | 15 | 13.65 ± 0.92 | 14.14 ± 0.94 | P>0.05 |
| MPV (fL) | 15 | 9.08 ± 1.08 | 9.41 ± 0.78 | P>0.05 |

*Abbreviations for haematological parameters: WBC (white blood cell), RBC (red blood cell), HGB (Haemoglobin), HCT (haematocrit), MCV (mean corpuscular volume), MCHC (mean corpuscular hemoglobin concentration), PDV (platelet distrubition width), PLT (platelet), LYM (lymphocyte), RDW-SD (red cell distribution width –standard deviation), RDW-CV (red cell distribution width –cell volume), MPV (mean platelet volume).

**Table 3.** The change in weight. systolic and diastolic blood pressure in non-exercising males

| | N | 0.Day Mean + St Dev | 12. Week Mean + St Dev | P |
|---|---|---|---|---|
| Weight (kg) | 15 | 79.07 ± 8.13 | 77.60 ± 7.44 | P<0.01 |
| Systolic blood pressure (mmHg) | 15 | 118.00 ± 9.41 | 116.67 ± 9.00 | P>0.05 |
| Diastolic blood pressure(mmHg) | 15 | 76.00 ± 8.28 | 72.67 ± 8.84 | P>0.05 |

**Table 4.** The change in certain biochemical parameters in exercising males

| Biochemical Parameters | n | O. Day (Exercising Before) Mean + St Dev | 12. Week (Exercising After) Mean + St Dev | P |
|---|---|---|---|---|
| Glucose (mg/dl) | 15 | 104.60 ± 12.28 | 101.93 ± 11.32 | P>0.05 |
| Urea (mg/dl) | 15 | 26.60 ± 8.67 | 24.40 ± 8.39 | P≤0.05 |
| Creatine (mg/dl) | 15 | 0.973 ± 0.349 | 1.080 ± 0.833 | P>0.05 |
| Cholesterol (mg/dl) | 15 | 208.7 ± 59.4 | 141.3 ± 54.3 | P<0.01 |
| Triglyceride (mg/dl) | 15 | 185.6 ± 45.5 | 140.6 ± 41.0 | P<0.01 |
| HDL (mg/dl) | 15 | 42.33 ± 6.97 | 48.60 ± 8.01 | P<0.01 |
| AST (U/L) | 15 | 31.47 ± 11.19 | 28.40 ± 9.13 | P≤0.01 |
| ALT (U/L) | 15 | 29.53 ± 11.08 | 18.07 ± 6.04 | P<0.01 |
| GGT (U/L) | 15 | 41.67 ± 21.45 | 36.67 ± 16.18 | P>0.05 |
| ALP (U/L) | 15 | 141.7 ± 65.7 | 120.4 ± 41.1 | P>0.05 |
| CK (U/L) | 15 | 97.87 ± 24.22 | 74.87 ± 30.38 | P>0.05 |
| CK-MB (U/L) | 15 | 18.00 ± 4.05 | 15.53 ± 4.39 | P>0.05 |
| LDH (U/L) | 15 | 190.2 ± 32.1 | 230.6 ± 73.8 | P≤0.05 |
| Uric Acid (mg/dl) | 15 | 4.093 ± 0.630 | 3.827 ± 0.775 | P>0.05 |
| Ca (mg/dl) | 15 | 9.293 ± 0.581 | 9.200 ± 0.510 | P>0.05 |
| Fe (ug/dl) | 15 | 91.13 ± 27.60 | 72.20 ± 25.80 | P≤0.01 |

*Abbreviations for biochemical parameters: HDL (high density lipoprotein), AST (aspartate aminotransferase), ALT (alanine aminotranferase) GGT (gamma-glutamyl transpeptidase), ALP (alkaline phosphatase), CK (creatine kinase), CK-MB (creatine kinase MB), LDH (lactate dehydrogenase), Ca (calcium), Fe (iron).

**Table 5.** The change in certain hematological parameters in exercising males

| *Haematological parameters* | n | O. Day (Exercising Before) Mean + St Dev | 12. Week (Exercising After) Mean + St Dev | P |
|---|---|---|---|---|
| WBC (fL) | 15 | 7.84 ± 1.07 | 7.99 ± 1.01 | P>0.05 |
| RBC (million/$mm^3$) | 15 | 5.97 ± 0.96 | 6.28 ± 0.58 | P>0.05 |
| HGB (gr/dl) | 15 | 15.98 ± 1.11 | 16.43 ± 0.94 | P<0.05 |
| HCT (%) | 15 | 49.20 ± 4.98 | 51.80 ± 4.80 | P≤0.01 |
| MCV ($\mu m^3$) | 15 | 87.16 ± 7.15 | 88.37 ± 6.67 | P>0.05 |
| MCHC (gr/dl) | 15 | 36.36 ± 2.91 | 37.42 ± 2.18 | P<0.05 |
| PDV (%) | 15 | 15.37 ± 1.81 | 15.91 ± 1.55 | P<0.05 |
| PLT (/$mm^3$) | 15 | 278.4 ± 24.1 | 261.7 ± 55.1 | P>0.05 |
| LYM (/$mm^3$) | 15 | 30.76 ± 5.13 | 31.51 ± 5.23 | P>0.05 |
| NEUTROPHIL (/$mm^3$) | 15 | 67.21 ± 10.95 | 62.57 ± 24.06 | P>0.05 |
| RDW-SD (%) | 15 | 52.14 ± 7.81 | 52.65 ± 7.89 | P>0.05 |
| RDW-CV (%) | 15 | 13.71 ± 2.57 | 13.41 ± 2.44 | P>0.05 |
| MPV (fL) | 15 | 9.26 ± 1.76 | 9.65 ± 2.20 | P>0.05 |

*Abbreviations for haematological parameters: WBC (white blood cell), RBC (red blood cell), HGB (Haemoglobin), HCT (haematocrit), MCV (mean corpuscular volume), MCHC (mean corpuscular hemoglobin concentration), PDV (platelet distrubition width), PLT (platelet), LYM (lymphocyte), RDW-SD (red cell distribution width–standard deviation), RDW-CV (red cell distribution width –cell volume), MPV (mean platelet volume).

**Table 6.** The change in weight. systolic and diastolic blood pressure in exercising males

| | N | O. Day (Exercising Before) Mean + St Dev | 12. Week (Exercising After) Mean + St Dev | P |
|---|---|---|---|---|
| Weight (kg) | 15 | 82.67 ± 7.83 | 78.67 ± 7.30 | P<0.01 |
| Systolic blood pressure (mmHg) | 15 | 118.67 ± 7.43 | 119.33 ± 7.99 | P>0.05 |
| Diastolic blood pressure(mmHg) | 15 | 77.33 ± 5.94 | 73.33 ± 9.76 | P>0.05 |

**Table 7.** The change in certain biochemical parameters in non-exercising females

| Biochemical Parameters | n | 0. Day Mean + St Dev | 12. Week Mean + St Dev | P |
|---|---|---|---|---|
| Glucose (mg/dl) | 15 | 118.47 ± 13.65 | 99.53 ± 12.12 | P<0.01 |
| Urea (mg/dl) | 15 | 22.20 ± 7.36 | 22.40 ± 7.83 | P>0.05 |
| Creatine (mg/dl) | 15 | 0.983 ± 0.488 | 0.813 ± 0.333 | P>0.05 |
| Cholesterol (mg/dl) | 15 | 188.9 ± 62.4 | 179.7 ± 32.4 | P>0.05 |
| Triglyceride (mg/dl) | 15 | 220.4 ± 65.2 | 209.7 ± 71.7 | P>0.05 |
| HDL (mg/dl) | 15 | 38.93 ± 7.10 | 44.67 ± 9.45 | P<0.05 |
| AST (U/L) | 15 | 26.67 ± 11.40 | 28.60 ± 10.27 | P>0.05 |
| ALT (U/L) | 15 | 25.07 ± 7.67 | 28.33 ± 7.93 | P>0.05 |
| GGT (U/L) | 15 | 30.27 ± 13.67 | 29.13 ± 13.75 | P>0.05 |
| ALP (U/L) | 15 | 83.9 ± 41.5 | 128.3 ± 43.5 | P≤0.01 |
| CK (U/L) | 15 | 79.00 ± 22.68 | 130.67 ± 36.84 | P<0.01 |
| CK-MB (U/L) | 15 | 20.73 ± 5.27 | 14.87 ± 3.98 | P<0.01 |
| LDH (U/L) | 15 | 215.3 ± 49.1 | 201.1 ± 62.0 | P>0.05 |
| Uric Acid (mg/dl) | 15 | 3.353 ± 1.169 | 4.007 ± 0.551 | P<0.05 |
| Ca (mg/dl) | 15 | 8.713 ± 1.309 | 9.167 ± 0.370 | P>0.05 |
| Fe (ug/dl) | 15 | 86.53 ± 32.54 | 78.47 ± 30.82 | P>0.05 |

*Abbreviations for biochemical parameters: HDL (high density lipoprotein), AST (aspartate aminotransferase), ALT (alanine aminotranferase) GGT (gamma-glutamyl transpeptidase), ALP (alkaline phosphatase), CK (creatine kinase), CK-MB (creatine kinase MB), LDH (lactate dehydrogenase), Ca (calcium), Fe (iron).

**Table 8.** The change in certain hematological parameters in non-exercising females

| *Haematological parameters* | n | O. Day Mean + St Dev | 12. Week Mean + St Dev | P |
|---|---|---|---|---|
| WBC (fL) | 15 | 7.11 ± 1.23 | 6.68 ± 1.10 | P>0.05 |
| RBC (million/$mm^3$) | 15 | 5.26 ± 0.43 | 5.54 ± 0.56 | P<0.05 |
| HGB (gr/dl) | 15 | 13.31 ± 1.94 | 13.60 ± 1.29 | P>0.05 |
| HCT (%) | 15 | 40.61 ± 3.46 | 41.87 ± 3.57 | P<0.05 |
| MCV ($\mu m^3$) | 15 | 77.04 ± 12.61 | 77.73 ± 12.72 | P>0.05 |
| MCHC (gr/dl) | 15 | 314.9 ± 18.5 | 329.8 ± 38.5 | P>0.05 |
| PDV (%) | 15 | 17.06 ± 1.53 | 16.81 ± 1.27 | P>0.05 |
| PLT (/$mm^3$) | 15 | 274.6 ± 88.0 | 287.7 ± 71.3 | P>0.05 |
| LYM (/$mm^3$) | 15 | 32.97 ± 5.01 | 34.33 ± 7.00 | P>0.05 |
| NEUTROPHIL (/$mm^3$) | 15 | 55.56 ± 8.08 | 56.13 ± 8.06 | P>0.05 |
| RDW-SD (%) | 15 | 39.83 ± 3.87 | 40.46 ± 3.57 | P>0.05 |
| RDW-CV (%) | 15 | 14.92 ± 2.11 | 15.42 ± 1.71 | P>0.05 |
| MPV (fL) | 15 | 9.53 ± 2.55 | 9.67 ± 2.32 | P>0.05 |

*Abbreviations for haematological parameters: WBC (white blood cell), RBC (red blood cell), HGB (Haemoglobin), HCT (haematocrit), MCV (mean corpuscular volume), MCHC (mean corpuscular hemoglobin concentration), PDV (platelet distrubition width), PLT (platelet), LYM

(lymphocyte), RDW-SD (red cell distribution width –standard deviation), RDW-CV (red cell distribution width –cell volume), MPV (mean platelet volume).

**Table 9.** The change in weight systolic and diastolic blood pressure in non-exercising females

| | n | 0.Day Mean + St Dev | 12. Week Mean + St Dev | P |
|---|---|---|---|---|
| Weight (kg) | 15 | 67.73 ± 6.04 | 68.00 ± 5.81 | P>0.05 |
| Systolic blood pressure (mmHg) | 15 | 116.00 ± 11.83 | 116.00 ± 11.83 | P>0.05 |
| Diastolic blood pressure(mmHg) | 15 | 68.67 ± 7.43 | 68.67 ± 8.34 | P>0.05 |

**Table 10.** The change in certain biochemical parameters in exercising females

| Biochemical Parameters | n | O. Day (Exercising Before) Mean + St Dev | 12. Week (Exercising After) Mean + St Dev | P |
|---|---|---|---|---|
| Glucose (mg/dl) | 15 | 107.64 ± 13.40 | 102.21 ± 10.54 | P≤0.01 |
| Urea (mg/dl) | 15 | 19.07 ± 5.08 | 18.50 ± 4.59 | P>0.05 |
| Creatine (mg/dl) | 15 | 0.700 ± 0.262 | 0.891 ± *** | P>0.05 |
| Cholesterol (mg/dl) | 15 | 175.7 ± 23.3 | 135.1 ± 37.8 | P<0.01 |
| Triglyceride (mg/dl) | 15 | 184.2 ± 80.4 | 116.6 ± 31.2 | P<0.01 |
| HDL (mg/dl) | 15 | 47.43 ± 6.48 | 51.00 ± 4.99 | P<0.01 |
| AST (U/L) | 15 | 14.71 ± 2.67 | 17.86 ± 3.82 | P<0.05 |
| ALT (U/L) | 15 | 15.21 ± 2.39 | 15.71 ± 3.79 | P>0.05 |
| GGT (U/L) | 15 | 12.09 ± 2.71 | 11.64 ± 2.74 | P>0.05 |
| ALP (U/L) | 15 | 79.9 ± 14.2 | 120.1 ± 46.7 | P≤0.01 |
| CK (U/L) | 15 | 76.57 ± 6.85 | 101.07 ± 26.67 | P≤0.01 |
| CK-MB (U/L) | 15 | 14.1 ± 2.4 | 30.4 ± *** | P>0.05 |
| LDH (U/L) | 15 | 250.14 ± 22.86 | 179.36 ± 29.69 | P<0.01 |
| Uric Acid (mg/dl) | 15 | 3.37 ± 0.71 | 3.96 ± 0.70 | P>0.05 |
| Ca (mg/dl) | 15 | 8.87 ± 0.67 | 9.50 ± 0.72 | P<0.05 |
| Fe (ug/dl) | 15 | 116.71 ± 10.34 | 81.00 ± 27.19 | P<0.01 |

*Abbreviations for biochemical parameters: HDL (high density lipoprotein), AST (aspartate aminotransferase), ALT (alanine aminotranferase) GGT (gamma-glutamyl transpeptidase), ALP (alkaline phosphatase), CK (creatine kinase), CK-MB (creatine kinase MB), LDH (lactate dehydrogenase), Ca (calcium), Fe (iron).

**Table 11.** The change in certain hematological parameters in exercising females

| *Haematological parameters* | n | O. Day (Exercising Before) Mean + St Dev | 12. Week (Exercising After) Mean + St Dev | P |
|---|---|---|---|---|
| WBC (fL) | 15 | 7.38 ± 1.10 | 7.08 ± 1.07 | P>0.05 |
| RBC (million/mm$^3$) | 15 | 4.96 ± 0.66 | 5.83 ± 0.71 | P<0.01 |
| HGB (gr/dl) | 15 | 13.18 ± 1.61 | 14.02 ± 1.04 | P<0.05 |
| HCT (%) | 15 | 40.91 ± 2.64 | 41.52 ± 2.47 | P>0.05 |
| MCV (µm$^3$) | 15 | 82.90 ± 7.95 | 84.00 ± 8.98 | P>0.05 |
| MCHC (gr/dl) | 15 | 34.15 ± 2.86 | 36.30 ± 3.65 | P>0.05 |
| PDV (%) | 15 | 16.82 ± 1.26 | 16.65 ± 1.26 | P>0.05 |
| PLT (/mm$^3$) | 15 | 301.0 ± 64.1 | 307.2 ± 70.6 | P>0.05 |
| LYM (/mm$^3$) | 15 | 34.94 ± 4.64 | 36.10 ± 5.09 | P<0.05 |
| NEUTROPHIL (/mm$^3$) | 15 | 61.96 ± 14.90 | 65.43 ± 19.11 | P>0.05 |
| RDW-SD (%) | 15 | 66.32 ± 14.45 | 67.20 ± 16.34 | P>0.05 |
| RDW-CV (%) | 15 | 15.22 ± 2.83 | 15.42 ± 1.95 | P>0.05 |
| MPV (fL) | 15 | 8.94 ± 1.57 | 9.62 ± 2.11 | P>0.05 |

*Abbreviations for haematological parameters: WBC (white blood cell), RBC (red blood cell), HGB (Haemoglobin), HCT (haematocrit), MCV (mean corpuscular volume), MCHC (mean corpuscular hemoglobin concentration), PDV (platelet distrubition width), PLT (platelet), LYM (lymphocyte), RDW-SD (red cell distribution width –standard deviation), RDW-CV (red cell distribution width –cell volume), MPV (mean platelet volume).

**Table 12.** The change in weight systolic and diastolic blood pressure in exercising females

| | n | O. Day (Exercising Before) Mean + St Dev | 12. Week (Exercising After) Mean + St Dev | P |
|---|---|---|---|---|
| Weight (kg) | 15 | 69.40 ± 7.28 | 65.33 ± 8.39 | P>0.05 |
| Systolic blood pressure (mmHg) | 15 | 116.00 ± 11.83 | 117.33 ± 11.00 | P>0.05 |
| Diastolic blood pressure(mmHg) | 15 | 70.67 ± 8.84 | 68.00 ± 6.76 | P<0.05 |

**Table 13.** The age difference in exercising and non-exercising males and females

| | n | Exercising Mean + St Dev | Non-Exercising Mean + St Dev | P |
|---|---|---|---|---|
| Males | 15 | 32.00 ± 5.07 | 33.33 ± 5.46 | P>0.05 |
| Females | 15 | 33.93 ± 5.82 | 32.60 ± 4.73 | P>0.05 |