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The Impact of Short-Term Exercise and Coffee Consumption on Some Biochemical Parameters

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ABSTRACT

The present study aimed to examine the effects of short-term exercise and short-term coffee consumption on routine clinical laboratory tests. Coffee consumption experimental protocol involved 20 volunteers. The participants drank 3 cups of coffee at an interval of less than half an hour (~780 mg of caffeine for 3 cups). Blood specimens were collected before and after 90 minutes of coffee drinking. Exercise experimental protocol involved 25 volunteers whose ages were between 23 to 45 years. The exercise trial included training that lasted for 40 minutes at a 5.5 km/hour speed. Blood samples were obtained before and after a 10-minute treadmill training session and a 2-hour period after exercise. The coffee consumption substantially reduced *alkaline phosphatase* (ALP), alanine transaminase (AST) ALT, and aspartate transaminase (AST) levels, while it dramatically increased mean blood glucose levels. There were no significant variations (P>0.05) in high-density lipoprotein (HDL), low-density lipoprotein (LDL), *creatine kinase-MB* (CK-MB), *lactate dehydrogenase* (LDH), creatinine, gamma-glutamyl transferase (GGT), and α-amylase levels before and after coffee consumption. The treadmill activity substantially increased CK-MB, LDH, and creatinine levels, while glucose level was significantly decreased (P<0.05). There were no significant differences in the levels of ALT, AST, ALP, GGT, α-amylase, HDL, and LDL between before, 10 minutes and 2 hours of exercise. (P>0.05) LDH activity was shown to be considerably higher in the younger group when compared to older one after exercise (P<0.05). The short-term physical activity and coffee consumption were linked to pre-analytical changes in a number of clinical laboratory tests.

Keywords: Exercise, Coffee consumption, Clinical parameters, Laboratory analysts.

Introduction

Coffee is one of the most consumed drinks worldwide.[1] It is rich in bioactive substances, particularly methylxanthines (e.g. caffeine), phenolic compounds (e.g. chlorogenic acids), minerals (e.g. potassium, magnesium), and nicotinic acid (vitamin B3).[2,3] Coffee consumption and demand are increasing worldwide due to the belief that it has many beneficial health effects such as anti-oxidant activity, anti-migraine effect, anti-inflammatory, antithrombotic effects and anticancer effects besides improving non-communicable diseases.[1,4] Previous studies demonstrated that coffee consumption is inversely correlated with certain forms of cancer,[5] metabolic syndrome, [6] liver disease,[7] and Parkinson's disease.[8] Regular coffee consumption contributed to risk decline in cardiovascular diseases mortality to about 19% compared to non-coffee drinkers, due to its antioxidant properties which may lead to enhancing insulin sensitivity.[9] Heavy coffee consumption (i.e. people who drink more than 6 cups/day) was associated with an increase in serum concentration of LDL-C, Apo lipoprotein B, and total cholesterol.[10] The consumption of three or more cups a day contributed to elevated total cholesterol and LDL level in individuals.[11] Triglycerides and LDL levels showed a significant decrease following a daily six-week treatment with coffee.[12]

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Research results revealed that coffee could increase insulin sensitivity, thus help to prevent the development of diabetes mellitus.[13] Previous reports also revealed that coffee consumption was associated with a lower risk of developing many liver diseases. [14,15] This is due to coffee components (Phenolic, caffeine, and melanoidins) that have antioxidant effects on the liver. Drinking coffee is associated with a decrease in AST and GGT, while no significant effect on ALT was appeared in healthy Korean men.[16] Previous studies showed that coffee consumption was significantly associated with several positive and protective effects on renal function manifested in reduced risk of renal impairment, chronic kidney disease, and end-stage renal disease.[1,17] Another report showed that coffee consumption caused an increase in serum creatinine level in rats.[18] Coffee consumption reduced serum uric acid level,[19] thus, reducing possibility of gout disease.[20] Daily coffee consumption has a protective effect against chronic kidney disease and albuminuria, as it lowers serum albumin concentration and increases glomerular filtration rate.[21] LDH level increased significantly in athletes post caffeine intake.[22]

Over decades, the relationship between the effects of exercise on lipid has been extensively studied. Several studies have shown that exercise can successfully lower serum lipid levels, prevent thrombosis and arteriosclerosis, reduce heart stress and avoid cardiovascular illnesses.[23] Exercise also increases levels of HDL, thus, protecting against the progression of cardiovascular disease.[24] Previous findings revealed an increased level of ALT and AST after high-intensity exercise.[25] Aerobic exercise causes an elevation in AST and ALT activity in males and females immediately after exercise and returned to normal after one hour rest.[26] Alkaline phosphatase (ALP), gamma glutamyl transferase (GGT) and bilirubin in both sexes did not alter significantly after exercise, while the levels of total protein and albumin were decreased significantly after exercise.[27] High-intensity exercise was associated with a higher risk of loss of renal function in the male groups compared to female counterparts.[28]

Physical exercise may lead to a remarkable rise in serum creatinine concentrations due to increased creatinine secretion from muscle tissues.[29] It also increased both serum Lactate dehydrogenase LDH[27] and Creatine kinase (CPK) activities.[30] Creatine kinase -MB)CK-MB) level was significantly increased after exercise and lasted for 2 days.[31] A previous study showed that severe exercise may affect the concentration of CK, but not CK-MB level.[32] Regular exercise appears to be effective in the treatment of a variety of metabolic illnesses, including obesity, hypertension, and diabetes.[33] In fact, physical exercise supports muscle absorption of glucose.[34] Many studies indicated that activation of the sympathetic nervous system leads to a higher release of α-amylase and cortisol levels.[35] Therefore, the current study was conducted to investigate the effect of coffee consumption and short term exercise, on some clinical laboratory tests in healthy male subjects.

Materials and Methods

Study population

The study was conducted from 5 March to 13 April 2021 in Amman, Jordan. Forty-five (n=45) male healthy volunteers participated in the study. The inclusion criteria include: (i) apparently healthy Jordanian volunteers; (ii) non-smoking male volunteers aged between 23 to 45 years, while the exclusion criteria were: (i) smokers, alcoholics and overweight; (ii) people with chronic diseases such as kidney disease; (iii) older than 50 years old (iv) participants who took any medication or supplement such as paracetamol or multivitamin during the last two weeks before the study. The average body weight of participants was 80.0 ± 4.6 kg. Informed written consent was taken from each participant prior to the commencement of the study in which the benefits and/or risks of participating in the study were explained. A health history questionnaire was filled out by each participant prior to the start of the study

Effect of coffee consumption on some clinical laboratory tests

Twenty Jordanian male volunteers (n=20) between the ages of 20 to 45 took part in the study to investigate the effect of coffee consumption on biochemical parameters. In less than half hour interval, every participant drank thee cups of coffee (200 mL per cup, about 600 mL for thee cups, each cup contains 260 mg of caffeine). One day prior to the experiment, participants were advised to stop consuming coffee. Blood samples were collected before and 90 minutes after coffee consumption, all blood samples were separated at Al Jubaiha Medical Labs (Amman, Jordan) to obtain sera samples. A control group was made up of all blood samples taken before coffee consumption. Serum specimens were kept in an icebox and transported to the Faculty of Allied Medical Sciences/Al-Ahliyya Amman University research laboratories for biochemical parameters determination.

Effect of exercise on some clinical laboratory tests

Twenty five Jordanian male volunteers (n=25) ranging in age from 23 to 45 years were involved in exercise experiment. To examine if there was a link between exercise and age, participants were divided into two age groups, the first aged 23 to 34 years old and the second aged 35 to 45 years old. The participants were asked to walk quickly on a treadmill (Techno-Gym, USA) for at least 40 minutes at 5.5 km/hour speed. The entire experiment roughly lasted for 90 min under the ideal temperature (22^{o}C). The rest period given was 2 h after completion of the exercise. The participants were asked to have approximately 250 mL of water 2 h before the starting of an experiment to prevent dehydration. Besides, they were also asked not to be fasting for at least 3 hours before the experiment. This study was performed at the fearless Gym (Khalda, Amman, Jordan). Blood samples were taken before, 10 minutes and 2 h after the exercise to assess serum biochemical parameters. The pre-exercise baseline blood specimens were used as the study's control specimens.

Blood sample collection

Two samples each with 5 mL of intravenous blood samples were obtained by venipuncture from the median antecubital vein using a sterile, non-pyrogenic needle from each participant and dispensed into sterilized clot activator tube. Serum was obtained by centrifugation at the speed of 4000 rpm for 10 minutes and separated into two Eppendorf tubes; one stored at -20C^{o} as a backup; the second was used for biochemical analysis. The serum clinical laboratory tests, including gamma-glutamyl transferase (GGT), aspartate aminotransferase (AST) and alanine aminotransferase (ALT), alkaline phosphates (ALP), lactate dehydrogenase (LDH), creatinine kinase muscle-brain (CK-MB), creatinine, glucose, low-density lipoprotein (LDL) and high-density lipoprotein (HDL) were determined by Fully Automatic Huma Star 200 Biochemistry analyzers (serial number. 21190008001, Germany). Three controls of various levels were performed with each run. Calibration was performed when the outcome of control falls outside 2 standard deviations (SD).

Experimental procedure for caffeine extraction

100 mL of water were added to 13 g of coffee in a 400 mL beaker. After adding 5 g of calcium carbonate to the suspension, it was heated for 10 minutes. The tannins (organic substances) should be converted to insoluble salts by the calcium carbonate, which will subsequently precipitate out of solution. After that, the suspension was filtered through a funnel with filter paper to capture and eliminate all insoluble particles. The filtrate that contains the caffeine was collected. After cooling to room temperature, the filtrate was placed into a 125-mL reparatory funnel. 10 mL of methylene chloride was added to the filtrate then the whole mixture was shacked gently. Caffeine was dissolved in methylene chloride layer gathered from the bottom of the separator funnel. Then the caffeinated layer was separated in a beaker whose weight was taken before and was 54.34 g. The process of separation was repeated twice to make sure that all caffeine in the filtrate was collected. The beaker containing the caffeine dissolved in methylene chloride was placed in a water bath at 90C^{o} for 15 minutes to evaporate the methylene chloride completely and to leave only the caffeine in the beaker. After the evaporating process, weight of the beaker containing the caffeine, was measured and found to be equal to 54.5987 g. Thus, the weight of caffeine was 0.260 g.

Statistical analysis

Statistical analysis was performed using IBM SPSS statistical software version 28.0 (SPSS Inc., Chicago, IL, US). The data were defined as means ± SD. Comparison of biochemical test values from the same participant before and after coffee consumption was performed using a paired sample t-test. Changes from pre-exercise (baseline), 10 minutes and 2 h after exercise were analyzed as well using the one-way analysis of variance (ANOVA) with Bonferroni post hoc test. P-values lower than 0.05 were considered of statistical significance. The figures were created using a Microsoft power point.

Results and Discussion

Effects of coffee consumption on biochemical parameters of the volunteers

The effect of coffee that was taken orally by the volunteers (n=20) on the biochemical parameters are presented in Table 1. There was a significant ($p < 0.001$) difference between pre- and post-coffee consumption in serum levels of ALT and AST and ALP (ALT: 25.85 ± 6.65 U/L vs. 22.05 ± 5.16 U/L, AST: 26.60 ± 4.43 U/L vs. 23.45 ± 3.23 U/L, 175.90 ± 44.86 U/L vs. 158.30 ± 37.12 U/L, respectively. The mean of glucose blood levels in the pre and post-coffee consumption group were 99.8 3 ± 8.11 mg/dl vs. 108.25 ± 12.61 mg/dl; respectively. Thus, glucose blood levels were significantly increased after the coffee consumption ($P < 0.001$), compared with that before the consumption (Table 1). Previous studies revealed that caffeine consumption caused a significant increase in blood glucose concentration.[36] Coffee includes bioactive compounds, principally caffeine, which acts as an adenosine receptor antagonist, namely though the adenosine A2A receptor, which is critical for glucose homeostasis.[37] Inhibiting the activation of adenosine receptors has been linked to reduced insulin sensitivity in many studies.[38]

Caffeine, according to previous researches, causes the release of catecholamines in the blood, notably adrenaline, which has been

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related to poor insulin sensitivity and glucose control in healthy volunteers.[39] This study demonstrated that short-term coffee intake by healthy volunteers decreases liver enzyme levels, particularly ALT, AST, and ALP. This study with previous studies, which indicated that coffee consumption, lowers liver enzyme levels in those who drink more than three cups of coffee per day.[40] The effect of coffee drinking appeared to be very rapid in altering the level of liver enzymes as the decrease in these enzymes starts 60 minutes post having coffee. In this regard, the findings can be explained by the fact that coffee physiologically includes active components such as caffeine and polyphenolic chemicals with antioxidant, anti-inflammatory, and anti-fibrotic properties.[41] Accordingly, coffee consumers have lower levels of inflammatory biomarkers than non-coffee drinkers.[42] Previous studies have also shown that coffee compounds, especially caffeine, reduce or eliminate reactive oxygen species and oxidized glutathione and increase the level of reduced glutathione thus contributing to protection against oxidative stress besides preventing free radical tissue damage.[43]

On the other hand, the current study found no significant link ($P > 0.05$) between short-term coffee consumption and GGT activity, which is consistent with previous research.[44] According to this study, short-term coffee drinking showed no influence ($P<0.05$) on lipid profiles such as HDL and LDL in healthy individuals. Such results are consistent with previous reports on the effect of short-term coffee consumption on lipid serum levels in healthy people[44] but contradicts with several studies that indicated a substantial rise in total cholesterol, LDL, and triglycerides following coffee consumption.[46, 47] Different sample sizes and the presence of other factors, such as coffee type, coffee additives, consumption rate, and preparation methods, could explain the disparities between the studies. The findings of this study are consistent with those of other investigations.[48, 49] There was no discernible difference in creatinine, LDH, or CK-MB levels before and after coffee drinking ($P > 0.05$).

Effects of exercise on biochemical parameters of the volunteers

Table 2 shows the biochemical parameters levels in healthy participants pre-, 10 minutes and 2 hours post- exercise. ALT, AST and ALP Serum levels are shown in Table 2. The levels of LDH, CK-MB, creatinine, and glucose were significantly different (LDH; $P< 0.003$, CK-MB; $P<0.011$, creatinine; $P < 0.014$, glucose; $P < 0.002$) between the same volunteers prior and after the exercise. (Table 2 and Figures 1 - 4). The current findings reveal that after a 10-minute rest period, 40 minutes of moderate-intensity short-duration exercise causes a considerable increase in blood creatinine levels in healthy people. After 2 hours of rest, creatinine levels returned to pre-exercise levels. This is due to the release of phosphate groups contained in muscle creatine, which results in elevated levels of creatinine in blood. The findings are consistent with previous studies that have indicated an increase in blood creatinine levels following a short-term exercise.[50]

In the current study, the CK-MB serum level was considerably higher in the 10 minutes following exercise CK-MB level returned to pre-exercise levels after 2 hours of rest. Previous studies found that short-term [51, 52] or long-term exercise[53] increase the level of CK-MB. This could be traced back to enhanced cardiac myocardium activity, which releases high levels of this enzyme into the bloodstream.[54] Blood LDH level increased significantly in the 10 minutes following exercise, as revealed in the current study, which agrees with previous studies that looked at changes in LDH activity levels after short-term physical exercise. Several investigations on LDH activity after long-term exercise support our findings.[56,57] Because LDH is a muscle activity indicator,[58] higher LDH activity levels could suggest exercise-induced muscle weariness.[59] Results of the present study showed that the levels of LDL and HDL cholesterol do not change after the exercise. It was observed that HDL and LDL concentration levels did not alter after 30 minutes of moderate intensity exercise.[34]

Table 1: The values of serum biochemical parameters studied in healthy volunteers pre- and post-coffee consumption (Mean ± SD; n = 20)

Parameters	Pre-consumption	Post-consumption
ALP (U/L)	175.90 ± 44.86	158.30 ± 37.12*
ALT (U/L)	25.85 ± 6.65	22.05 ± 5.16*
AST(U/L)	26.60 ± 4.43	23.45 ± 3.23*
GGT (U/L)	37.50 ± 11.56	37.50 ± 11.37
LDH (U/L)	315.60 ± 41.51	315.55 ± 42.04
CK-MB (U/L)	14.35 ± 3.08	14.25 ± 3.38
Amylase (U/L)	60.25 ± 10.25	60.00 ± 10.51
Creatinine (mg/dl)	0.92 ± 0.10	0.92 ± 0.098
Glucose (mg/dl)	99.83 ± 8.11	108.25 ± 12.61*
LDL (mg/dl)	69.32 ± 11.15	69.36 ± 10.85
HDL (mg/dl)	63.44 ± 10.59	63.48 ± 10.84

t: Student t test, *: Significant difference ($P<0.001$) between pre- and post-coffee consumption.

Table 2: The levels of serum biochemical parameters in healthy volunteers before and after exercise (Mean ± SD; n = 25).

Parameters	Pre-exercise	10 minutes post-exercise	2-h post-exercise
ALP (U/L)	166.52 ± 42.85	167.36 ± 42.38	166.40 ± 42.68
ALT (U/L)	25.72 ± 6.50	25.92 ± 6.74	25.56 ± 6.63
AST (U/L)	24.24 ± 5.13	24.52 ± 5.16	24.04 ± 5.24
GGT (U/L)	32.36 ± 11.36	32.88 ± 11.09	32.32 ± 10.88
LDH (U/L)	312.08 ± 40.57	370.44 ± 70.33	350.12 ± 62.41*
CK-MB (U/L)	14.04 ± 3.72	17.08 ± 3.59	14.80 ± 3.52*
Amylase (U/L)	59.96 ± 10.03	59.32 ± 10.29	59.60 ± 9.90
Creatinine (mg/dl)	0.92 ± 0.12	1.04 ± 0.16	0.95 ± 0.13*
Glucose (mg/dl)	98.46 ± 8.73	88.96 ± 10.61	95.96 ± 9.30*
LDL (mg/dl)	74.71 ± 10.83	74.42 ± 10.99	74.14 ± 11.04
HDL (mg/dl)	63.65 ± 13.41	68.99 ± 14.52	65.14 ± 13.69

*Statistically significant. LDH; $P< 0.003$, CK-MB; $P<0.011$, creatinine; $P < 0.014$, glucose; $P < 0.002$)

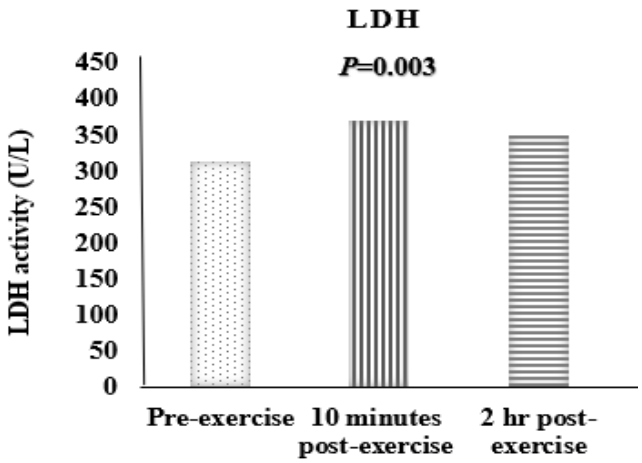

Figure 1: The mean levels of serum LDH at pre- and the post-exercise groups.

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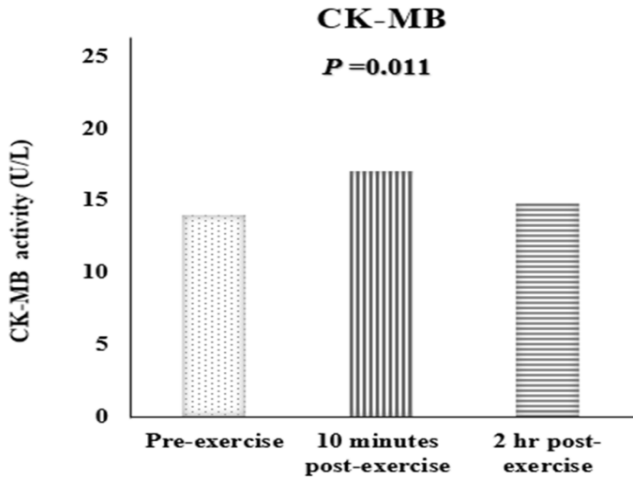

Figure 2: The mean levels of serum CK-MB at pre- and the post-exercise groups.

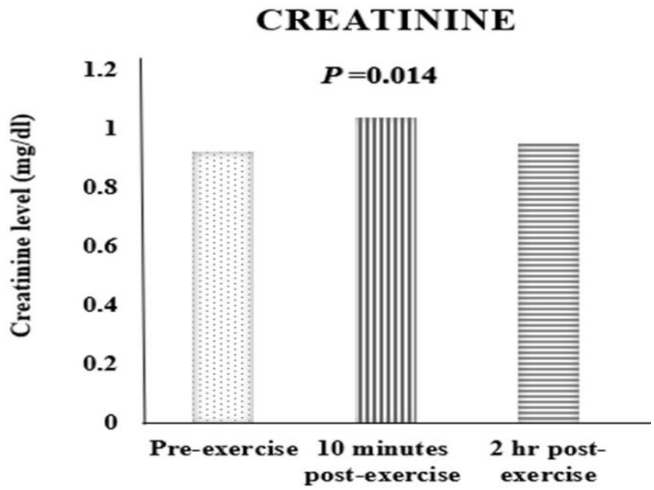

Figure 3: Serum creatinine mean values at pre, 10 minutes and 2-h post-exercise.

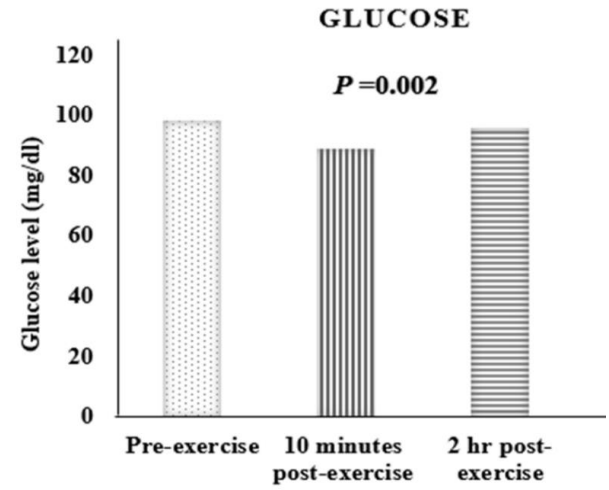

Figure 4: Blood glucose mean at pre-10 minutes and 2-hrs post-exercise.

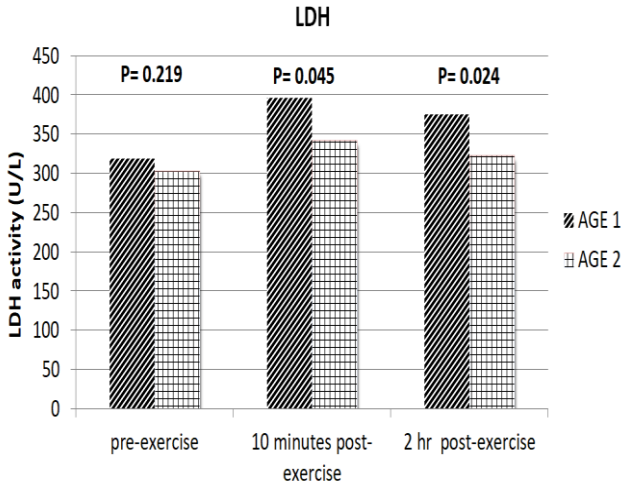

Figure 5: The relationship between serum LDH activity levels and different age groups at pre-, 10 minutes post-exercise, and 2-h post-exercise groups.

According to a review of literature, there are few studies that have examined the influence of short moderate-intensity exercise on blood glucose levels in healthy individuals. The present study demonstrated a decreased level of blood glucose after 10 minutes of exercise and returned to their original level in 2 hours after the end of exercise. It was reported that blood glucose levels decreased after 30 minutes of moderate intensity exercise.[34] The current study showed a decrease in blood glucose levels which is most likely related to acute aerobic exercise, which increases in insulin sensitivity for several hours due to the temporary activation of AMP-activated protein kinase.[60] Furthermore, during the exercise, glucose stores (glycogen) which is reabsorbed in the muscle increases hepatic glucose synthesis via the glycogenolysis and gluconeogenesis pathways.[34] The study also revealed that s alpha-amylase serum levels did not alter after the moderate-intensity exercise.

Age difference and the level of LDH were shown to be related among the volunteers 10 minutes and 2 h after exercise compared with that before exercise (Figure 5). After 10 minutes of exercise, LDH serum concentration was significantly higher in the younger volunteers in comparison with the aged ones (P = 0.045). Also, after 2 h of exercise, LDH serum activity levels were clearly higher in the younger volunteers in comparison with the aged ones (P = 0.024). LDH levels were closely tied to muscle size, resulting in a considerable rise in its activity during exercise, in contrast with what was found in the elderly, who got smaller muscles due to aging.

Conclusion

Results of the current study unveiled the potential role of coffee consumption in raising blood glucose levels and in lowering ALT, AST, and ALP levels. They also revealed that short-term exercise raised the levels of CK-MB, LDH, and creatinine. In addition, it lowered glucose concentrations. Furthermore, LDH activity was greater in the younger age group than the older age group.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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