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Effect Of Aerobic, Anaerobic and Resistance Exercises on Oxidative Stress Status in Healthy Sport Practitioners

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ABSTRACT: The main aim of this study is to assess the effect of three different types of exercises on lipid peroxidation in sports practitioners. The experimental approach was used to conduct the study. Sixty-six healthy male sport practitioners were participated in this study and divided into three experimental groups, each group consist of 22 subjects, the 1st, 2nd, and 3rd groups performed aerobic (AE), anaerobic exercises (AnE), and resistance exercises (RE). Before entering their experimental program, the three groups conducted the beep test for determining the VO2max for each participant, and then the blood and urine samples were taken from each participant. Thereafter, the three groups entered their specific training program for eight weeks 3 times/week. After ending the training programs, the three groups conducted the beep test again. All statistical data analyses were performed using SPSS version 25. For checking the differences between the pre- and post-test for all groups one-way ANOVA with Post Hok-Tukey was conducted. Comparisons between pre-test and post-test within one type of exercise were performed by the paired sample t-test. The effect of the three types of exercise programs for 8 weeks on lipid peroxidation biomarker (urinary MDA level) was varied. Interestingly, the 3 types of sport exercises were found to have a great effect on increasing serum antioxidants levels and decrease the levels of urinary MDA. Following the aerobic exercise, which was found to be significantly the more effective in decreasing the level of urinary MDA than anaerobic and resistance exercises. However, the resistance and aerobic exercises have a greater effect to generate the antioxidants defense than anaerobic exercise.

Keywords: Aerobic Exercises, Anaerobic Exercises, Resistance Exercises, Malondialdehyde, Total Antioxidants.

1. Introduction

Recently, the unfortunate events that appear in the sports field have increased between those who lost their lives during some exercise or during the competition or suffered from faint for a long time or nervous convulsions while practicing sports, whether this person was a professional athlete or he was a sport practitioner (Abdullah and Ahmad, 2014). The main reason behind these events is due to the size of sports training as well as the athlete's exposure to many environmental, physical and psychological pressures, which affects the performance and physiological aspects of the athlete's body, which led the researchers to study these abnormal and dangerous phenomena (Al-Mandalawi, 1989). Many researchers have reached the vital and important role with which these free radicals invade the cell and destroy the cell membrane and its organelles, and cause malfunction and disorder that a person may not notice at the beginning such as colds due to affecting of temperature regulation mechanism and other serious diseases such as arteriosclerosis, diabetes, kidney and liver diseases, cancer, retinopathy, arthritis, and aging progressing diseases that medicine is still unable to face most of them (Abdullah and Ahmed, 2014). It has been recommended that the regular physical activities decrease the risk factor of obesity, cardiovascular, diabetes mellitus and cancer diseases, because of its beneficial effects. However, strenuous physical activity also remarkably increases the level of oxygen consumption as much as more as 10 times than the resting level (Robert et al., 2016). It has been noted that the level of oxygen consumption and electron transport disturbance could cause and generate the superoxide free radicals (Scott, et al., 2011), and it is accepted that aerobic exercise results in more ROS production (Carolina, et al., 2018). Furthermore, some studies have suggested that anaerobic exercise involves less oxygen circulation in the body than aerobic exercise (Harsh, et al., 2017).

The state of oxidative stress is a result of a disturbance in the balance between oxidants and the antioxidant defense systems (Birben et al., 2012). Oxidative stress became an interesting subject for many physical exercise scientists, trainers, specialists in sport exercises and sport nutrition scientists. Although some studies indicate that increased damage to proteins, lipids, and DNA is related to physical exercise have been well investigated (Ammar, et al., 2020, Bloomer, 2008), however, in some researches, the signs of exercise-induced oxidative stress were unable to be observed (Margaritis, et al., 1997). These conflicting results motivated the researcher to investigate the effect of physical exercise on oxidative stress for sport practitioner. It is reasonable to assume that the potential principal factor that causes oxidative stress is rising up the level of oxygen consumption. the level of lipid peroxidation remarkably raises immediately and up to 48 hours after the physical effort. The level of lipid peroxidation remarkably rises immediately and up to 48 hours after the physical effort of resistance exercises (Ammar, et al., 2016), short-term maximal sprints (Baker, et al., 2004) and anaerobic exercise which performed near the threshold (Ammar, et al., 2020). The major sources of free radical production that causes oxidative stress during physical exercise have been identified to the mitochondrial electron transport chain complex, local inflammation, and the phenomenon of ischemia-reperfusion injury (Bloomer et al., 2004). It was found previously that, the immediate increases in the content of uric acid and total oxidant were reported after intensive resistance, sprint, and Wingate efforts (Hammouda et al., 2012), with a returning to the baseline occurs from 10 min (El Abed et al., 2011) and up to 8 hours (Ammar et al., 2016). These findings obviously described the intensive physical exercise as a condition resulting in oxidative stress, characterized by severe and delayed redox imbalance between oxidants and antioxidants.

Although, it is still unclear which type of exercise results in the greatest oxidative stress responses, however, a few studies have investigated the impact of the type of exercises on oxidative stress genesis. These studies have just focus on aerobic and anaerobic exercises. It has been suggested that anaerobic exercise induces a less increase in oxidative stress status comparing to aerobic exercise (Bloomer et al., 2007; Parker et al., 2014). Other studies demonstrated that there were no differences between aerobic and anaerobic exercise activities with respect to enzymatic antioxidant defense (Inal et al., 2001), whereas it was shown that the increase in exercise intensity resulting in endogenous antioxidant defenses (Parker et al., 2018). There for that the main aim of the current study is to investigate the effect of three different types of exercises (aerobic, anaerobic and resistance) on urinary lipid peroxidation biomarker (MDA) and total serum antioxidants level in sport practitioner before and after training program for eight weeks.

2. Subjects, Materials and Methods

The experimental approach was used to conduct the study. Sixty-six male healthy sport practitioners from 1st year students were participated in this study during the academic year 2018–2019 in the College of Physical Education and Sport Sciences, University of Duhok. They were divided into three equal experimental groups, the first group performed aerobic exercises (AE) and the second group performed anaerobic exercises (ANE), while the third group, performed resistance exercises (RE).

3. Experimental Design

One week before entering the experimental period the three groups conducted the beep test for the VO2max estimation for each participant, and then the blood and urine samples were taken from the participants and transported to lab. After that, the 3 groups were entered the training program for 8 weeks, 3 times /week. the first group performed aerobic exercises starting with 20 min running in the first week and end up with 45 min running, the second group performed anaerobic exercises which consisted of a group of sprintings for example (4×30m, 3×40m and 2×50m), and the third group performed resistance exercises which each session involved 8 exercises with 3 sets and 10 repetitions for example (Bench Press, Bench Press dumbbells, Squats, Lat Pull-down, Triceps Pushdown, Barbell Curl, Leg curl, concentration curl). After ending the training programs, the three groups conducted the beep test again for determining the VO2max, and the blood samples and urine samples were taken from the participants The blood tubes were stored directly in cooling ice bag as soon as collected and during the quick transportation to the medical postgraduate research laboratory in the College of Medicine, University of Duhok. The serum isolation was done by centrifugation at 3500 rpm in a cooling centrifuge at 4c° for 30 minutes; the separated serum immediately was taken and stored in deep freezers at -28c° for estimation of biochemical parameters.

All blood analysis tests were performed in the same laboratory for control inter-assay variance. Total antioxidants (TAS) serum level was measured by using Human Total antioxidants ELISA Kit use of the commercial assay Kit from Sun Red Biotechnology Company reference DZE201127412. The lipid profile tests including High-Density Lipoprotein (HDL), Low-Density Lipoprotein (LDL), Triglyceride (TG), Cholesterol (Chol), very low-density lipoprotein (VLDL) was done using a Kenza 240TX device present at biochemistry lab, college of Health Sciences, University of Duhok. Urinary Malondialdehyde (MDA) was assayed as a marker of lipid peroxidation using a urinary strip of the Bio Doctor (BS-502) a portable urine analyzer. The MDA measurement was done directly as soon as the samples arrived to the lab.

The device BF508 was used for determination of the body composition (Body weight, BMI, Visceral Fat level (VF) and Body Fat percentage (BF), manufactured by Omron model (HBF-508-E) with a serial number (846692).

4. Statistical Analysis

All statistical data analyses were performed using SPSS version 25 for checking the differences between the pre-test for all groups for the purposes of homogeneity and equivalence of the sample one-way ANOVA with Post Hok Tukey was conducted, and the same for the post-test for checking the significance between the three groups. Comparisons between pre-test and post-test within one type of exercise were performed by the paired sample t-test. P value was set to < 0.05 be statistically significant.

5. Results

Table 1 shows the mean ± standard deviation of the demographic variables in the study. No significant differences were found between the 3 groups were found. The number of smokers is 18 out of 66 subjects with (27.3%).

Table 1: The mean ± SD of the demographic of the study variables for Pre-tests program

Variables	Aerobic N=22	Anaerobic N=22	Resistance N=22	P-value
	Mean ± SD	Mean ± SD	Mean ± SD	
Age (years)	20.58 ± 1.3	21.25 ± 2.1	21.66 ± 2.25	0.15
Height (cm)	175.75 ± 7.25	176.54 ± 5.9	176.41 ± 6.5	0.20
Body mass (kg)	67.52 ± 6.5	71.4 ± 9.1	70.31 ± 9.3	0.81
BMI (kg/m2)	22.15 ± 2.42	23.09 ± 2.33	22.89 ± 2.44	0.368

Table 2 shows the pre and the post sport programs results. There were no significant differences between the three groups for all variables in pre sport programs. While a significant difference was found between the three groups after the post sport in BMI (p = 0.01), VF (p = 0.03), MDA (p = 0.01) and TAS (p = 0.02), whereas there is no significant difference were found in BF (p = 0.23) and VO2max (p = 0.49).

Table 2: The mean ± SD of the studied variables of the pre and post sport programs tests

Variables	tests	Aerobic group N=22	Anaerobic group N=22	Resistance group N=22	P-value
		Mean ± SD	Mean ± SD	Mean ± SD	
BMI (kg/m2)	Pre	22.15 ± 2.42	23.09 ± 2.33	22.89 ± 2.44	0.37
	post	21.37 ± 1.9	22.70 ± 2.1	23.82 ± 1.6	0.01*
Body Fat (%)	Pre	17.07 ± 5.69	19.84 ± 5.7	19.12 ± 7.5	0.31
	post	13.20 ± 3.1	15.31 ± 4.5	14.39 ± 4.2	0.23
Visceral Fat (level)	Pre	5.9 ± 2.48	6.7 ± 2.49	5.79 ± 3.37	0.44
	post	4 ± 1.5	5.2 ± 2	3.5 ± 1.5	0.03*
VO2max (ml/kg/min)	Pre	39.64 ± 5.4	38.98 ± 7.5	38.77 ± 7.4	0.89
	post	42.73 ± 3.8	42.54 ± 5.2	44.16 ± 5.4	0.49
MDA (fp)	Pre	824.87 ± 411.03	702.62 ± 245.37	768.41 ± 286.87	0.42
	post	426.87 ± 81.5	541.66 ± 133.9	623.91 ± 208.4	0.01*
TAS (ng/ml)	Pre	3.08 ± 0.98	3.44 ± 0.86	3.46 ± 0.89	0.28
	post	6.27 ± 2.8	5.08 ± 2.4	7.30 ± 2.9	0.02*

* $p \leq 0.05$

Table 3 shows the mean ± SD and p-values of the lipid profile of the pre and post sport programs samples, it shows that there were no significant differences between the three groups in pre-test, while there was a significant difference between the three groups in post-test variables. For the serum TG (p = 0.03), VLDL (p = 0.01), while there were no significant differences were found in serum HDL (p = 0.18) and LDL (p = 0.18) and Chol (p = 0.50).

Table 3: The serum lipid profile tests variables of the pre and post sport programs

variables	tests	Aerobic group N=22	Anaerobic group N=22	Resistance group N=22	P-value
		Mean ± SD	Mean ± SD	Mean ± SD	
HDL (mmol/L)	Pre	40.16 ± 9.3	42.45 ± 9.76	40.83 ± 7.34	0.66
	post	54.54 ± 22.8	47.37 ± 15.5	58.16 ± 21.3	0.18

TG (mmol/L)	Pre	72.67 ± 25.01	88.08 ± 36.61	87.79 ± 50	0.24
	post	66.75 ± 18.1	88.70 ± 38.8	101.08 ± 61.1	0.03*
Chol (mmol/L)	Pre	141.16 ± 33.41	148 ± 24.55	151.29 ± 30.75	0.49
	post	145.29 ± 28.6	140.37 ± 20.4	149.29 ± 28.8	0.51
LDL (mmol/L)	Pre	86.46 ± 25.64	87.31 ± 24.22	91.97 ± 29.20	0.74
	post	83.13 ± 24.1	77.46 ± 16.1	70.16 ± 28.4	0.18
VLDL (mmol/L)	Pre	14.82 ± 4.18	16.58 ± 7.84	18.31 ± 9.9	0.29
	post	13.26 ± 3.8	18.12 ± 7.77	21.14 ± 13.1	0.01*

* $p \leq 0.05$

Table 4: Paired t-test between pre and post-tests variables within each group

variables	Aerobic			Anaerobic			Resistance		
	Pre	**post**	**P**	**pre**	**post**	**P**	**pre**	**post**	**P**
BMI (kg/m2)	21.93 ± 2.5	21.32 ± 1.2	0.02	23.13 ± 2.3	22.65 ± 2.05	0.02	22.67 ± 2.5	23.94 ± 1.62	0.02*
BF (%)	16.89 ± 5.5	13.08 ± 3.1	0.01	20.15 ± 5.9	15.40 ± 4.44	0.01	18.53 ± 7.61	14.78 ± 4.81	0.01*
VF (level)	5.73 ± 2.5	3.96 ± 1.5	0.01	6.73 ± 2.6	5.15 ± 2.01	0.01	5.54 ± 3.39	3.70 ± 1.62	0.01*
VO2Max (ml/kg/min)	39.77 ± 5.2	42.88 ± 3.7	0.01	38.71 ± 7.3	42.18 ± 5.33	0.02	38.79 ± 7.15	40.48 ± 5.1	0.06*
HDL (mmol/L)	40.17 ± 9.3	54.54 ± 22.8	0.01	42.46 ± 9.8	47.38 ± 15.5	0.22	40.83 ± 7.35	58.17 ± 21.28	0.02*
LDL (mmol/L)	86.47 ± 25.7	83.13 ± 24.1	0.66	87.17 ± 24.8	77.46 ± 16.11	0.08	91.97 ± 29.20	70.17 ± 28.37	0.01*
VLDL (mmol/L)	14.83 ± 4.19	13.26 ± 3.8	0.12	16.63 ± 7.8	18.12 ± 7.78	0.49	18.32 ± 9.9	21.14 ± 13.11	0.22
Ur. MDA (fp)	824.87 ± 411.1	426.78 ± 81.5	0.01	702.62 ± 245.4	541.66 ± 133.9	0.01	768.41 ± 268.9	623.91 ± 208.4	0.02*
TAS (ng/ml)	3.08 ± 0.9	6.28 ± 2.7	0.01	3.45 ± 0.8	5.09 ± 2.37	0.03	3.47 ± 0.9	7.30 ± 2.87	0.01*

* $p \leq 0.05$

Fig. 1 showed that urinary MDA value was significantly decreased in comparison between AE and ANE ($p < 0.02$), also there was significant different in comparison between AE and RE ($p < 0.01$)

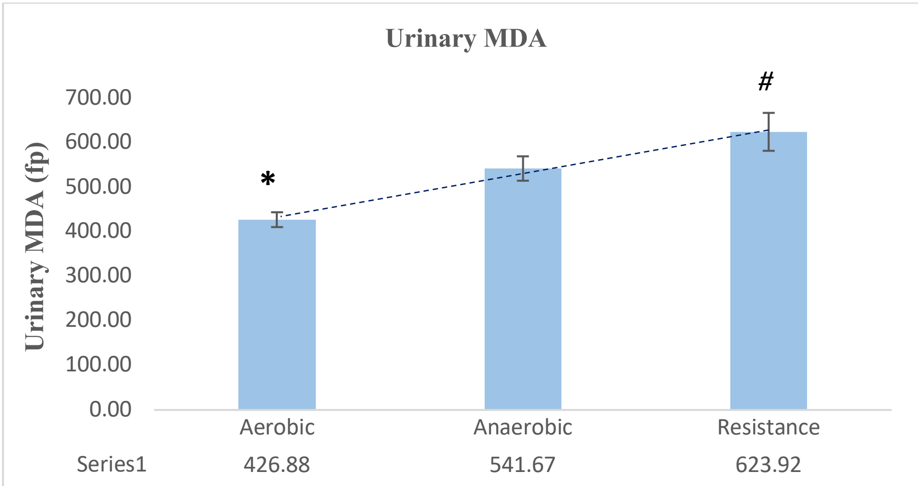

Figure 1: shows changes in MDA and intragroup comparison for post-test in the study groups.
* Presence of a significant difference between AE and ANE ($p < 0.02$)
# Presence of a significant difference in comparison between AE and RE ($p < 0.01$)

Fig. 2 shows the changes in serum TAS and intergroup comparison for post-test in the study groups. TAS was significantly decreased in comparison between ANE and RE ($p < 0.01$).

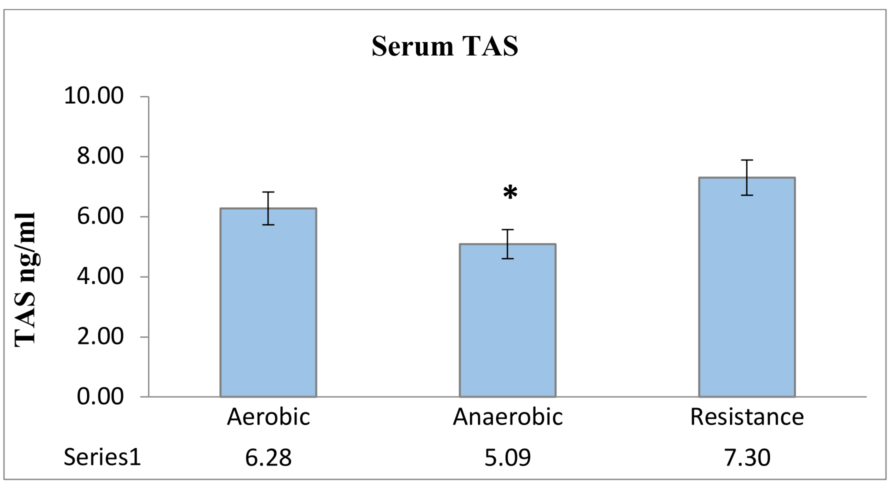

Figure 2: A comparison of Serum TAS Levels for Post-test in the study groups

* TAS showed a significant different between ANE and RE ($p < 0.01$)

6. Discussion

It is well known that the production of oxidants increases with an elevating metabolic rate as a result of contractions of skeletal muscles (Hargreaves and Lawrence, 2020). Moreover, during exercise, the oxygen consumption is increased by 10-15 times compared to a resting state and therefore the free radical production capacity of mitochondria increases temporarily. The increase in O2 uptake concomitant with physical exercise is related to a rise in the production of reactive oxygen species ROS by cells and tissues. The types of sport exercise may affect ROS production and antioxidants defense system. Immediately, after the ends of interventions (8 weeks of exercise performing) a reduction was found in BMI, TG, VLDL, urinary MDA, and an elevation in the level of serum TAS after following the three programs of exercise. By comparing the results between pre and post intervention, a significant difference between pre and post-test were found for BMI for the three intervention groups, which means the three kinds of exercise have a positive effect on reducing BMI. These results are supported by previous research who found a significant reduction in BMI with aerobic, anaerobic, and resistance exercises (Al Saif and Alsenany 2015; Fernandez et al., 2004; Willis et al., 2012). Similarly, for HDL there were significant different between pre and post tests for the three kinds of exercises, which mean the three kinds of exercises have positive effect on improving HDL level in the blood, as this supported by some previous studies (Mann et al., 2013; Ohta et al., 2019).

These results offer insight into participation in exercise to reduce the effect of oxidative stress development in healthy sports practitioners. It is still under debate the influence of exercise-type on the oxidative stress response. Indeed, some researchers have stated that following aerobic exercise results in a significant increase in oxidative stress (Baker et al., 2004; El Abed et al., 2019). While other researcher has found no changes between pre- and post-exercise in MDA levels (Park, and Kwak 2016). Also, there was a significant MDA increment between the pre and post exercises (Baker et al., 2014; El Abed et al., 2019, Ascensão et al., 2008). However other researchers found insignificant different present between the pre and post physical activities (Svensson et al., 1999). Following training resistance exercise, the MDA concentration was found to be significantly decreased after 6 weeks of exercise (Hayriye et al., 2010). The improvement of the body defense against the ROS production was found in this study can explain the benefit of using of sport training program (table 2) which is highly important for the reduction of urinary MDA in the post exercise programmed samples found. in this study. This could be occurred because of increased ROS catabolism, and its excretion or redistribution in the body (Leaf, et al., 1997). The other explanation of this decrease in MDA that occur after resistance exercise program may include the recovery times between each exercises and sets. As it knew a short recovery period (30 – 90) second is recommended for low intensity with high training volume, and a long recovery period (2 – 5) min is recommended for high intensity with low training volume (Baechle, et al., 2000).

In addition, comparing the post test results between groups (Fig.1) it was indicated that there is a significant difference between aerobic and anaerobic groups, the same was shown between aerobic and resistance groups. This proves that the aerobic exercise is more beneficial to reduce the level of lipid peroxidation. The same result observed by Radak et al., (2013), who stated that a regular aerobic exercise increases the level of antioxidants and decreases the level of MDA.

The results of total serum antioxidants level showed that there was a significant difference between anaerobic and resistance groups, which mean aerobic and resistance exercises results were better in improvement of TAS level than anaerobic exercise. Previously, it was suggested that increasing the concentrations of antioxidant enzymes leads to minimizing the oxidative damage which is related to the increase of free radical production (Ammar et al., 2020).

The current results confirm the suggestion that the pre-post exercise showing significant increases for the antioxidant defense regardless of the kind of exercise. Further, the present findings are in line with the previous research stating increased enzymatic antioxidant following aerobic exercise, with low intensity running (Ji, 1999) or swimming (Inal et al., 2001), anaerobic exercise, such as intermittent (6 × 150 m) sprints (Margaritis, et al., 1997) and resistance exercise (Azizbeigi et al., 2014). The enzymatic antioxidants levels could be attributed to the increase of the oxygen consumption, and improved blood circulation.

7. Conclusion

The results of this study demonstrate, the effect of three types of exercise (aerobic, anaerobic and resistance) on lipid peroxidation and total antioxidants defense for sport practitioners after participating in intervention for 8 weeks' sport program. In general sport exercise has a great effect on increasing antioxidants level in blood and decrease the level of MDA, following aerobic exercise is more effective to decrease the level of MDA than anaerobic and resistance exercises. However, the resistance and aerobic exercises has greater effect to generate the antioxidants than anaerobic exercise.

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