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The Effects of Different Intensities of Sub Maximal Aerobic Exercise on Proteinuria and Hematuria in Active Young Men

[1]Mohammad Ali Kohanpour, [2]Mohammad Hassan Boostani,
[1]Mahdiye Nasiri Avanaki, [2]Mohammad Ali Boostani, [3]Amir Hamzeh Zare,
[1]Mona Mirsepasi, [1]Sepide Mirsaeidi and [4]Elahe Hamidi

[1]Department of Exercise Physiology, Faculty of Physical Education and Sports Sciences, Islamic Azad University, Central Tehran Branch, Tehran, Iran
[2]Islamic Azad University, Arsanjan Branch, Young Researchers Club, Fars, Iran
[3]Department of Exercise Physiology, Shiraz University, Shiraz, Iran
[4]Student of Corrective exercise and sport injuries, University of Tehran, Iran

Abstract: The purpose of this study was to determine the effects of different intensities of sub maximal aerobic exercise on proteinuria and hematuria in active young men. Eight active young men with the mean age of 23.33±1.54 years, height of 176±1.76 cm and weight of 67.16±3.14 kg participated in three sessions of aerobic activities including running with the intensity at 70, 80 and 90% of maximal heart rate for 30 min. Before, immediately after and one hour after the exercise, the urine sample was collected; then, each sample was tested for albumin, total protein, β_2-microglobulin, creatinine, protein to creatinine ratio and hematuria. Analysis of variance with repeated measurements along with LSD post-hoc test which was used for comparing and investigating the changes of variables. As the intensity of activities increased, urinary albumin excretion did not have any significant changes (P>0.05). The amount of urine albumin after exercising with the intensity at 90% of maximal heart rate was higher than its amount after exercising with two less intensities; however, this difference was not statistically significant (P>0.05). Also, as the intensity of activity increased, urine excretion of total protein and hematuria did not make any significant changes (P>0.05). But, urine excretion of β_2-microglobulin was surprisingly significant (P<0.05) and non-significant (P>0.05) in the exercises with the intensity at 70 and 80 & 90% of maximal heart rate, respectively. Urine excretion of creatinine was significantly increased during the one hour after exercises as the intensity of exercises increased from 70 to 90 and not to 80% of maximal heart rate. Protein to creatinine ratio at one hour after exercising with the intensity at 90% of maximal heart rate was less than its urine amount at one hour after exercising with the intensity at 70% of maximal heart rate (P<0.05); however, proteinuria was below the nephritic range. Although physical exercises increase the pressure on kidneys and urine excretion of protein, post-exercise proteinuria probably cannot limit the activities and is different from pathologic conditions.

Key words: Proteinuria · Aerobic Exercise · Albumin · B_2-microglobulin · Protein To Creatinine Ratio

INTRODUCTION

Unusual or excessive protein excretion in urine is a kidney disorder known as proteinuria. Proteinuria is one of the signs for some other important diseases like diabetes, high blood pressure, cardio-vascular diseases and renal diseases and, over time, leads to the destruction of kidneys [1]. Sports proteinuria which usually happens after physical exercises and is more conventional in severe exercises is a reversible and gradual process which has no clinical symptoms [2]. Following severe physical activities, protein excretion in urine is increased [3]. Change in glomerular membrane permeability relative to proteins and changes in renal hemodynamic during

Corresponding Author: Mohammad Ali Kohanpour, Department of Exercise Physiology, Faculty of Physical Education and Sports Sciences, Islamic Azad University, Central Tehran Branch, Tehran, Iran.

exercises are among the mentioned factors which lead to the increase in protein excretion [4]. During exercising, renal plasma flow decreases which is directly related to the intensity of exercises. In this process, it seems that sympathetic nerve activity and also hormonal systems are involved. Following the decrease in renal blood flow during the training, glomerular filtration rate also decreases [5].

Large proteins, such as globulin and albumin, cannot pass through glomerular membrane; therefore, very small amounts of them are observed in urine. However, in the case of glomerular damages, their amounts in urine increases; this condition is called glomerular proteinuria [2]. Proteins with lower molecular weights such as β_2-microglobulin easily pass through glomeruli; however, due to sufficient tubular re-absorption, these proteins are also found in very small amounts in urine [2, 6].

In medical conditions accompanied by tubular disorders, the presence of these proteins increases; a condition which is called tubular proteinuria. Renal disorders caused by sports activities were first reported in 1878 after observing the incidence of proteinuria in soldiers, who had hard physical activities [7]. Post-exercise proteinuria is a well-recognized phenomenon among human athletes, the severity of which depends on the intensity of the exercise [5, 6]. It has been suggested that the presence of excessive protein excretion in urine may be due to a disturbance in the selective permeability in the glomerulus associated or not with a saturation process in the re-absorption of the filtered protein load [6, 8]. These assumptions have been based on renal clearance of high and low molecular mass plasma proteins [6].

It has been reported that, when proteinuria is a consequence of tubular dysfunction, the amount of protein filtered by the glomeruli remains stable and the proteins with low molecular mass appear in larger quantities due to their incomplete tubular re-absorption [6, 9]. During exercises, the plasma flow rate in kidneys decreases, which is directly proportional to the exercise intensity. It seems that sympathetic nerves and also endocrine systems play a role in this process. As a result of decreasing renal blood flow rate, the glomerular filtration rate decreases, too [5]. There exists a close relationship between plasma decline and presence of albumin in urine, i.e., albuminuria [10].

Most sportsmen attending either contact or noncontact sports activities are observed to have a variety of proteins in their urine [11]. Glomerular type and both glomerular and tubular types have been observed after moderate and heavy exercises, respectively [12, 13]. Poortmans and Vancalck [14] reported the excretion of proteins after short strenuous exercises. They also reported the increase in total protein and albumin content as well as renal clearance increase after exercises. Carroll and Temte [15] reported proteinuria as a common problem among the adults attending sports activities. It was also reported that fever, high intensity physical or sports activities, body water loss, mental stress and serious diseases are benign and non-dangerous factors that may cause proteinuria. They proteinuria may be categorized as glomerular, tubular and overflow, among which glomerular type is the most pronounced one. Post-exercise proteinuria is a transient process, lasting approximately for one hour and the maximum proteinuria occurs in 20-30 min after exercises [2]. Although the quantitative assessment of proteinuria from 24-h urine collection still remains a gold standard for urinary protein estimation, protein to creatinine ratio provides a very useful, simple and convenient method for quantitative assessment of protein and can replace 24-h urine collection method [16].

Excessive excretion of proteins in urine may cause renal damage. One of the main issues that many researchers are concerned with around the world is the impact of physical activities on renal performance, in particular on proteinuria. Also, one particular current problem is the number of athletes who develop transient hematuria after running long distances [17]. Erythrocytes that arises from glomeruli shows great variation in size, shape and hemoglobin content whereas those coming from lesions such as infection, calculi, tumors and other non-glomerular sources are uniform in size and shape and usually retain a high hemoglobin content (except when urine is strongly acid). Red cells are present in the normal urine. Birch *et al*. [17] found that these red cells are glomerular in type and healthy people may have a urinary erythrocyte count below $8 \times 10^6/1$.

Though early studies have documented casts in the urine after exercises [11, 18, 19], recent research has focused on the bladder as the source of exercise hematuria. Urologists have described lesions of the bladder [20, 21] and attributed hematuria after exercises to the impact of the flaccid posterior wall of the bladder against the base of the bladder during running. A study of marathon runners by Siegel *et al*. [22] has been widely quoted as further evidence that exercise hematuria is not renal. They found hematuria in nine of 50 men (all doctors) after 42 km running but found no casts.

The purpose of the present study was to investigate the response of different intensities of aerobic exercises to proteinuria and hematuria in active young men.

MATERIAL AND METHODS

Participants: After calling for the participation in universities of Tehran and stating the research objectives, among 23 people who were volunteers to participate in the study, 10 active young male students were selected purposefully using convenience sampling. Two of them wanted to be removed from the study and 8 people with the mean age of 23.33±1.56 years old (with the age range of 21 to 25 years), height of 176±1.76 cm, weight of 67.16±3.14 kg, maximum oxygen consumption of 48.6±3.96 ml per kg of their body weight per min, BMI of 21.6±0.91 kg/square of height and resting heart rate of 68.55±3.74 beats per min remained in the study till the end. They had practiced at least two days per week during the last two years, had regular physical training and did not have any disease background. Also, at the time of study, they did not take any drugs for research purposes. It should be mentioned that, after selecting the participants, the required information with regard to the way of doing the research was presented to them and they signed a written testimonial.

Exercise Program: Five days before the research protocol, aerobic power of the participants was measured using Bruce test on treadmill [23]. Then, they came to the first exercise session. Three sessions of aerobic exercise included 30 min running on treadmill with three different intensities. These three exercise sessions were interfered with 48-h rest periods. In order to avoid misleading results caused by the effects of exercise sessions on each other, the order of exercise sessions was chosen on a random basis. Each participant attended 30 min of running on treadmill at 70, 80 and 90% of maximal heart rate. Maximal heart rate was obtained using this equation: 208 - (0.7 age) [24].

It should be mentioned that the participants were asked to avoid any kind of physical activities 48 h before starting the first session until the end of the last session. Moreover, they were asked to avoid drinking alcohol and caffeine the night before sampling and during research period in general.

Urine Samples Collection and Analysis: Before, immediately after and one hour after each session of activity, urine samples were collected from the participants. All the urine samples were maintained at -20° degrees Centigrade until reaching the laboratory; there, each sample's total protein, albumin, $\beta_2$microglobuline, creatinine and red globule along with protein to creatinine ratio were measured and calculated. Total protein, albumin, $\beta_2$microglobuline, creatinine and hematuria were measured using Bradford method by the Bradford kit (Bradford Publishing Co.) and with normal limit of 0-8 mg/dL, colorimetric method with Bromocrosol Green using Quick Chem kit (Carolina Biological Supply Co.) with normal limit of 30-300 mg/dL, ELISA method by Diametra kit (Diametra Co.) with the sensitivity level of 0.1 mg/dL with the normal limit of <2.0 mg/dL, colorimetric method using Quick Chem kit (Carolina Biological Supply Co.) with normal limit of 800-2000 mg/24h for men and using Cell Counting in Microscope method with normal limit of 0-4 RBC/HPF, respectively. Protein to creatinine ratio of urine was obtained after converting the unit of total protein to mg/24h using the equation: mg/dL×300 and dividing the obtained numbers by creatinine based on the basic unit of mg/24h.

Statistical Methods: $SPSS_{16}$ was used for doing statistical tests. For all statistical tests, the significance level of 0.05 was considered.

RESULTS

The amounts related to albumin, total protein, $\beta_2$microglobuline, creatinine, protein to creatinine ratio and red globule of urine before, (pre), immediately after (post 1) and one hour after (post 2) three sessions of aerobic activity with three different intensities at 70, 80 and 90% of maximal heart rate were given in Table 1. The means and standard deviations were reported as well.

Table 2 demonstrates the results of Analysis of Variance (ANOVA) with repeated measurements between the three exercise sessions. Also, Table 3 shows the results of Analysis of Variance (ANOVA) with repeated measurements for each exercise session.

No significant difference was observed between urine albumin of three sessions of activity with three different intensities at three measurement times (P>0.05).

Also, no significant difference was observed between total protein of urine in three activity sessions with three different intensities at three measurement times (P>0.05).

As far as $\beta_2$microglobulin was concerned, there was a significant difference after three sessions of activity with three different intensities (P= 0.039). The location

Table 1: Means and standard deviations of the measured variables

Variable	Exercise Sessions	Before Exercise	Immediately after Exercise	One hour after Exercise
Albumin (mg/24h)	Exercise with 70% MHR	91.375±10.225	84.75±11.937	112.88±26.319
	Exercise with 80% MHR	91.125±10.521	85.25±15.526	101.5±7.855
	Exercise with 90% MHR	91.5±10.474	90.25±15.266	123.88±31.073
Total Protein (mg/dL)	Exercise with 70% MHR	1.587±0.454	1.65±0.2	2.687±0.953
	Exercise with 80% MHR	1.55±0.389	1.712±0.418	1.887±0.723
	Exercise with 90% MHR	1.537±0.44	1.575±0.377	2.187±0.832
β_2- microglobulin (mg/dL)	Exercise with 70% MHR	0.987±0.364	1.037±0.150	1.362±0.362
	Exercise with 80% MHR	0.987±0.318	0.712±0.253	0.962±0.287
	Exercise with 90% MHR	0.987±0.348	1.175±0.468	1.368±0.400
Creatinine (mg/24h)	Exercise with 70% MHR	606.5±156.459	834.44±366.164	808.11±356.540
	Exercise with 80% MHR	607.5±154.331	1029.9±184.599	996.25±179.178
	Exercise with 90% MHR	611.25±151.067	1165.4±270.951	1348.5±351.999
Protein to Creatinine Ratio (mg/24h)	Exercise with 70% MHR	0.828±0.334	0.533±0.154	0.91±0.439
	Exercise with 80% MHR	0.810±0.297	0.498±0.118	0.563±0.184
	Exercise with 90% MHR	0.791±0.277	0.432±0.169	0.531±0.170
Hematuria (RBC/HPF)	Exercise with 70% MHR	1±0.755	1.125±0.640	3.375±2.774
	Exercise with 80% MHR	1±0.925	1.5±1.069	2.375±1.060
	Exercise with 90% MHR	1.125±0.991	1.75±1.164	4.25±2.604

MHR: Maximal Heart Rate

Table 2: Results of Analysis of Variance (ANOVA) with repeated measurements between the three exercise sessions

Variable	Time of Sampling	Sum of Squares	df	Mean Squares	F	P
Albumin	Pre	0.583	1.045	0.558	0.338	0.588
	Post 1	148	2	74	2.249	0.142
	Post 2	2002.75	2	1001.375	2.531	0.115
Total Protein	Pre	0.011	2	0.005	0.74	0.495
	Post 1	0.076	2	0.038	0.391	0.684
	Post 2	2.613	2	1.307	2.618	0.108
β_2-microglobulin	Pre	0.000	2	0.000	0.000	1
	Post 1	0.902	2	0.451	4.127	0.039 *
	Post 2	0.867	2	0.433	3.203	0.072
Creatinine	Pre	100.333	2	50.167	0.171	0.844
	Post 1	442861.503	2	221430.751	2.267	0.140
	Post 2	1203999.721	2	601999.861	4.988	0.023 *
Protein to Creatinine Ratio	Pre	0.006	2	0.003	0.897	0.430
	Post 1	0.042	2	0.021	0.886	0.434
	Post 2	0.705	2	0.353	4.525	0.030 *
Hematuria	Pre	0.083	2	0.042	0.046	0.955
	Post 1	1.583	2	0.792	0.649	0.538
	Post 2	14.083	2	7.042	1.299	0.304

*The mean difference is significant at the 0.05 level.

of this significant difference was between activities with the intensity at 70 and 80% of maximal heart rate ($P= 0.035$); however, interestingly, the excretion of urine β_2-microglobulin immediately after activity with the intensity at 70% of maximal heart rate was more than that immediately after the activity with the intensity at 80% of maxima heart rate. Moreover, there was no significant difference between urine β_2-microglobulin of three sessions of activity with three different intensities at two times of before and one hour after activity ($P> 0.05$).

A significant difference was observed between urine creatinine at one hour after three sessions of activity with three different intensities ($P= 0.023$). The location of this significant difference was between the activity with the intensity at 70 and 90% of maximal heart rate ($P= 0.050$). Excretion of creatinine at one hour after activity with the intensity at 90% of maximal heart rate was more than its excretion at one hour after the activity with the intensity at 70% of maximal heart rate. Furthermore, there was no significant difference between urine creatinine of three sessions of exercise with three different intensities at two times of before and immediately after activity ($P>0.05$).

Table 3: Results of Analysis of Variance (ANOVA) with repeated measurements within the exercise session

Variable	Exercise Sessions	Sum of Squares	df	Mean Squares	F	P
Albumin	70% MHR	3459.083	1.207	2866.383	9.36	0.012 *
	80% MHR	1083.25	2	541.625	5.465	0.018 *
	90% MHR	5814.25	2	2907.125	11.011	0.001 *
Total Protein	70% MHR	6.108	2	3.054	8.017	0.005 *
	80% MHR	0.456	2	0.228	2.362	0.131
	90% MHR	2.131	2	1.065	5.945	0.014 *
β_2-microglobulin	70% MHR	0.663	2	0.332	4.260	0.036 *
	80% MHR	0.37	2	0.185	3.047	0.080
	90% MHR	0.581	1.066	0.546	1.825	0.218
Creatinine	70% MHR	248789.51	1.012	245786.077	3.558	0.101
	80% MHR	881754.25	1.165	756991.953	21.177	0.001 *
	90% MHR	2357671.583	1.210	1948316.546	18.547	0.002 *
Protein to Creatinine Ratio	70% MHR	0.627	1.182	0.531	2.534	0.148
	80% MHR	0.432	2	0.216	7.878	0.005 *
	90% MHR	0.550	1.124	0.489	6.532	0.032 *
Hematuria	70% MHR	28.583	1.226	23.309	4.831	0.052
	80% MHR	7.750	2	3.875	7.843	0.005 *
	90% MHR	43.75	1.124	38.908	10.841	0.010

*The mean difference is significant at the 0.05 level.

There was a significant difference between protein to creatinine ratio of one hour after three sessions of activity with three different intensities (P= 0.030). The location of this significant difference was between the activity with the intensity at 70% of maximal heart rate and the activity with the intensity at 90% of maximal heart rate (P= 0.049). The excretion of urine protein to creatinine ratio at one hour after the activity with the intensity at 90% of maximal heart rate was less than its excretion at one hour after the activity with the intensity at 70% of maximal heart rate. Moreover, there was no significant difference between the urine protein to creatinine ratio of three sessions of activity with three different intensities at two times of before and immediately after the activity (P>0.05).

There was no significant difference between hematuria (urine excretion of red globules) of three sessions of activity with three different intensities at all three measurement times (P>0.05).

Changes of urine albumin in the activity with the intensities at 70, 80 and 90% of maximal heart rate were significant (P<0.05). Urine albumin in the activity with the intensity at 70% of maximal heart rate significantly increased from before till one hour after the activity (P= 0.050) and from immediately after until one hour after the activity (P= 0.002). In the activity with the intensity at 80% of maximal heart rate, urine albumin significantly increased from immediately after till one hour after the activity (P= 0.009). Also, urine albumin in the activity with the intensity at 90% of maximal heart rate significantly increased from before till one hour after the activity (P= 0.015) and from immediately after till one hour after the activity (P= 0.006).

Total protein changes of urine in the exercise with the intensities at 70% and 90% of maximal heart rate were significant (P<0.05) and was non-significant in the exercise with the intensity at 80% of maximal heart rate (P>0.05). In the activity with the intensity at 70% of maximal heart rate, total protein of urine significantly increased from before till one hour after the practice (P=0.020) and from immediately after until one hour after the activity (P= 0.023). Furthermore, total protein of urine in the activity with the intensity at 90% of maximal heart rate significantly increased from before until one hour after the activity (P= 0.048) and from immediately after till one hour after exercising (P= 0.020).

Changes of urine β_2-microglobulin were significant (P<0.05) and non-significant (P>0.05) in the exercises with the intensities at 70 and 80 & 90% of maximal heart rate, respectively. In the exercises with the intensity at 70% of maximal heart rate, urine $\beta_2$microglobulin made a significant increase from immediately after till one hour after the activity (P=0.014).

Changes of urine creatinine were non-significant and significant in the activities with the intensity at 70% of maximal heart rate (P>0.05) and in the activities with the intensities at 80 and 90% of maximal heart rate (P<0.05), respectively. In activities with the intensity at 80% of maximal heart rate, urine creatinine significantly increased from before till immediately after the activity (P=0.002) and from before till one hour after the activity (P= 0.003). Moreover, in the activities with the intensity at 90% of maximal heart rate, urine creatinine significantly increased from before to immediately after exercising (P= 0.004), from before till one hour after exercising (P= 0.003) and from immediately after till one hour after exercising (P= 0.022).

Changes of urine protein to creatinine ratio were non-significant and significant in the activity with the intensity at 70% of heart rate (P>0.05) and in the activities with the intensities at 80 and 90% of maximal heart rate (P<0.05), respectively. In activities with the intensity at 80% of maximal heart rate, urine protein to creatinine ratio significantly decreased from before till immediately after (P=0.012) and from before till one hour after exercising (P=0.036). Moreover, in the activities with the intensity at 90% of maximal heart rate, urine protein to creatinine ratio significantly decreased (P= 0.017) and increased (P=0.037) from before till immediately after the activity and from immediately after the activity till one hour after that, respectively.

Hematuria changes were non-significant (P>0.05) and significant (P<0.05) in the activities with the intensity at 70% of maximal heart rate and intensities at 80 and 90% of maximal heart rate, respectively. In the exercises with the intensity at 80% of maximal heart rate, hematuria significantly increased from before till one hour after exercising (P=0.004) and from immediately after till one hour after exercising (P=0.041). Moreover, in the activities with the intensity at 90% of maximal heart rate, hematuria significantly increased from before till one hour after the activity (P=0.014) and from immediately before till one hour after exercising (P=0.008).

DISCUSSION

According to the findings of the present study, excretion of urine albumin does not make any significant changes with the increase in the intensity of exercises. Although the amounts of urine albumin after exercising with the intensity at 90% of maximal heart rate were higher than its amounts after doing exercises with the two less intensity, this difference was not statistically significant. Moreover, urine excretion of total protein did not make any significant changes with the increase in the activity intensity.

Poortmans and Labilloy [25] reported that post-exercise proteinuria is more related to the activity intensity. Poortmans and Vancalck [14] showed that intense activity results in urinal excretion of albumin and total protein. Kramer *et al.* [26] reported the increase of albuminuria following heavy sports activities, which indicated glomerular origin of proteinuria [14].

The reason for the lack of difference between the excretion of albumin and total protein in the exercise with three different intensities is not known; however, it may be in the part related to the proximity of the three activities to each other and other factors like the level of physical activity of the participants. In the present research, urine albumin in the activities with the intensity at 70% of maximal heart rate significantly increased from before till one hour after and from immediately after till one hour after exercising. In the activities with the intensity at 80% of maximal heart rate, urine albumin significantly increased from immediately after till one hour after exercising. Moreover, urine albumin in the activities with the intensity at 90% of maximal heart rate significantly increased from before till one hour after exercising and from immediately after till one hour after exercising. Furthermore, based on the findings of the present study, changes in total protein of urine were significant and non-significant in the activities with the intensity at 70 and 90% of maximal heart rate and in the activities with the intensities at 80% of maximal heart rate, respectively. In the exercises with the intensity at 70% of maximal heart rate, total protein of urine significantly increased from before to one hour after exercising and from immediately after till one hour after exercising. Total protein of urine in the exercises with the intensity at 90% of maximal heart rate significantly increased from before till one hour after exercising and from immediately after till one hour after exercising.

Some researchers have shown that, following light physical activities, proteinuria is observed to increase only in some unhealthy, for example diabetic, sedentary people but this is not the case for the healthy ones [25]. Researchers have showed that urinary excretion of proteins increase after physical activities [7, 14, 27, 28] and this might be related to renal clearance increase [14].

Moreover, in the present research, there was a significant difference between urine $\beta_2$microglobulin immediately after three sessions of activity with three different intensities. The location of this significant difference was between the activity with the intensity at 70% of maximal heat rate and the activity with the intensity at 80% of maximal heart rate; however, interestingly, the excretion of urine $\beta_2$microglobulin immediately after the activity with the intensity at 70% of maximal heart rate was higher than its excretion immediately after exercising with the intensity at 80% of maximal heart rate. Moreover, there was no significant difference between urine $\beta_2$microglobulin at one hour after exercising with three different intensities. Surprisingly, in the present research, changes of urine $\beta_2$microglobulin in exercises were significant and non-significant with the intensity at 70% of maximal heart rate and in the activities with the intensities at 80 and 90% of maximal heart rate, respectively. In the exercises with the 70% of maximal heart rate, urine β_2-microglobulin significantly increased from immediately after till one hour after exercising.

This is in agreement with the previous studies which indicated that tubular proteinuria occurs with increasing physical activity intensity [14]. Poortmans and Vancalck [14] and Montelpare *et al*. [29] showed that periodic physical load increases $\beta_2$microglobulinuria. After exercise, high renal clearance of $\beta_2$microglobulinuria is observed, indicating that post-exercise proteinuria has also a tubular origin [14]. Poortmans *et al*. [30] showed β_2-microglobulin along with increasing blood lactate. Perhaps, several amino acids contributed to tubular re-absorption disorder. Under rest conditions, more than 95% of filtered proteins are re-absorbed by proximal tubular cell and converted to amino acids [30]. All amino acids are present in overflow proteinuria and tubular re-absorption is prevented as a result of absorption capacity completion.

Nevertheless, such results may be confusing; therefore, there is a need for more investigations in terms of finding the reasons for these results which should be done in future works.

Suzuki and Ikawa [31] stated that decreasing blood pH as a result of organic acids may change glomerular permeability and prevent from tubular absorption. This may be one of the reasons of increasing proteinuria as a result of heavy physical activities because it is known that heavy physical activities make body environment more acidic.

Turgut *et al*. [28] reported significant post-exercise proteinuria in both young men and women. The narrowing of renal arteries due to epinephrine and nor epinephrine increase during exercising may be one of the reasons for the increase of post-exercise proteinuria [5]. As renal blood flow decreases during exercising, glomerular filtration rate also decreases; since this decrease is less than that of renal blood flow, the filtration fraction increases and, as a result, passing through glomerular membrane becomes easier for high molecular weight proteins. Increase in plasma rennin activity which is observed during hard physical activities and is a result of glomerular sympathetic excitement that may affect post-exercise proteinuria [1, 32]. The mediation of Kallikrein, an enzyme of Kinin system, which is closely related to Renin-Angiotensin system, may increase the permeability of glomerular membrane. The loss of capillary wall negative charge may also be effective [1, 32]. Zambraski *et al.* [33] studied the variations of renal ciallic acids in response to exercise and stated that exercises decrease glomerular electrostatic resistance and might justify a part of increase in the passage of macromolecules. The role of factors like prostaglandins is also of importance and, if people take medicines that block prostaglandins production during exercising, proteinuria decreases significantly, provided that there is no renal hemodynamic change [34]. Kocer *et al*. [3], Gundoz *et al*. [35] and Senturk *et al*. [36] observed the increase in post-exercise proteinuria. The findings of Poortmans and Vancalck [14] and Clerico *et al*. [37] suggested that post-exercise proteinuria is very transient. Although the main factor affecting post-exercise proteinuria is activity intensity [14, 26], the activity duration is also effective [12, 37].

According to the findings of the present study, urine creatinine significantly increases after exercising with the increase in activity intensity. In fact, excretion of urine creatinine significantly increased with the increase in the activity intensity from 70% at maximal heart rate to the intensity at 90% and not 80% of maximal heart rate in the one hour after exercising. However, no significant difference was found between urine creatinine immediately after exercising with three different intensities. Furthermore, changes in urine creatinine were non-significant and significant in the activities with the intensity at 70 and 80 & 90% of maximal heart rate, respectively. In activities with the intensity at 80% of maximal heart rate, urine creatinine significantly increased from before to immediately after exercising and from before to one hour after exercising. Moreover, in the activities with the intensity at 90% of maximal heart rate, urine creatinine significantly increased from before to immediately after exercising, from before to one hour after activities and from immediately after till one hour after exercising. Also, considering the findings of the present study, a significant difference was found between urine proteins to creatinine ratio at one hour after three sessions of exercising with three different intensities. The location of this difference was between the activity with the intensity at 70% and 90% of maximal hearty rate;

the protein to creatinine ratio at one hour after the activity with the intensity at 90% of maximal heart rate was less than its urine amounts at one hour after the activity with the intensity at 70% of maximal heart rate. Additionally, no significant difference was observed between urine protein to creatinine ratio in three sessions of activity with three different intensities at two times of before and immediately after the activity. In this study, changes of urine protein to creatinine ratio were non-significant and significant in the activity with the intensity at 70% of maximal heart rate and in the activity with the intensities at 80 and 90% of maximal heart rate, respectively. In the activities with the intensity at 80% of maximal heart rate, the urine protein to creatinine ratio was significantly decreased from before till immediately after and from before until one hour after exercising. Also, in the activities with the intensity at 90% of maximal heart rate, urine protein to creatinine ratio significantly decreased and significantly increased from before till immediately after exercising and from immediately after till one hour after exercising, respectively. Determining the quantity of proteinuria requires collecting 24-h urine, which is mostly very difficult and can have some errors [16]. The obtained results which are reported as protein to creatinine ratio can be a substituent for the 24-h urine sample [38, 39].

The analysis of the findings of this paper demonstrated a significant correlation between proteins to creatinine ratio in the random sample of urine and the 24-h urine sample of the patients. Neithardt *et al*. [40] showed the correlation coefficient of 0.93 between 24-h urine excretion of protein and protein to creatinine ratio. Yamasmit *et al*. [41] also reported the correlation coefficient of 0.92 between these two variables. Robert *et al*. [42] indicated the correlation coefficient of 0.94 between the protein to creatinine ratio and level of 24-h proteinuria, which indicated a strong relationship between protein to creatinine ratio in the random sample of urine and 24-h proteinuria. Therefore, the protein to creatinine ratio in the random sample of urine can be a substituent for the time-consuming methods of collecting urine protein. In present study, this ratio was used for measuring the excretion of 24-h urine protein. Protein to creatinine ratio of less than 0.1, between 0.1 and 1 and more than 1 can be used in recognizing physiological, pathological and nephritic ranges of proteinuria, respectively [43]. It has been concluded that protein to creatinine ratio is more reliable for estimating the quantity of proteinuria and has wider applications. In fact, some weak correlation cases have been also reported. Nevertheless, the reason for weak correlation in the patients with renal failure can be due to the decrease in glomerular filtration [16, 43]. This correlation depends on glomerular filtration and is independent on gender, age and weight [16, 43]. Moreover, it has been said that the ratio of less than 0.2 indicates a normal domain of proteinuria while the proteinuria higher than 3.5 points toward the nephritic range of proteinuria [16]. Therefore, protein to creatinine ratio can be used for determining the significance and proteinuria [44].

In this study, proteinuria was lower than the nephritic range. Thus, although physical training increases pressure on the kidneys and urine excretion of protein, the possibility of post-exercise proteinuria cannot limit exercising and is different from pathological conditions. Finally, according to the findings of this study, there was no significant difference between hematuria in three sessions of activity with three different intensities at each measurement time; also, hematuria changes were non-significant and significant in the activities with the intensity at 70% of maximal heart rate and in the activities with the intensities at 80 and 90% of maximal heart rate, respectively. In exercises with the intensity at 80% of maximal heart rate, hematuria significantly increased from before till one hour after exercises and from immediately after till one hour after exercises. Additionally, in the activities with the intensity at 90% of maximal heart rate, hematuria significantly increased from before till one hour after exercising and from immediately after till one hour after exercising.

Exercise-induced hematuria is attributed to various mechanisms including increased body temperature, hemolysis, free radicals, lactic acidosis and catecholamine release [45]. Proteinuria is mainly influenced by exercise intensity rather than duration while hematuria depends on both duration and intensity [45, 46]. Therefore, some studies should be done to investigate the interaction of intensity and duration of activities.

In the present study, glomerular proteinuria and hematuria did not make any significant changes with the increase of activity intensity and this was probably due to the proximity of three intensities of the activities to each other. In this study, proteinuria was less than the nephritic range. Although physical training increases the pressure on kidneys and urine excretion of protein, post-exercise proteinuria cannot be limiting and is different from pathological conditions. Also, hematuria changes were non-significant and significant in the activities with the intensity at 70% of maximal heart rate and in the activity with the intensities at 80 and 90% of maximal heart rate, respectively. It is evident that still more studies are required.

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