Protein to Creatinine Ratio in Urine of Young Male Soccer Players in Response to Aerobic Activity at the altitude of 2500 Meter above the Sea Level

Mohammad Ali Kohanpour [1*], Mohammad Hassan Boostani [2], Mohammad Ali Manshadi [3], Mahdiye Nasiri Avanaki [1], Mona Mirsepasi [1], Amir Hamzeh Zare [4], Maghsoud Peeri [1], Mohammad Ali Boostani [2], Malihe Kohanpour [5]

[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, Iran
[3] Ph. D Student in Strategic Management of the Supreme National Defence University
[4] Department of Exercise Physiology, Shiraz University, Shiraz, Iran
[5] BSc. Physical Education and Sport Science
Corresponding author; Email: mkohanpur@gmail.com

Abstract: Effect of doing exercise at altitude on proteinuria has not been investigated in details. The purpose of this study was to evaluate quantity of proteinuria in response to aerobic activity at hypoxia and normoxia conditions. 10 young soccer players volunteered to participate in two sessions of aerobic activity including 30 min of running with 70% of maximum heart rate in two normoxia (altitude of 1200 m) and hypoxia (altitude of 2500 m) conditions. Total amount of protein and creatinine of urine was measured before and 10 min after the activity and protein to creatinine ratio of urine was also measured to evaluate 24 h proteinuria excretion. T-student statistical method which was special for dependent groups was used to investigate variations of the variables. No significant difference was found between hypoxia and normoxia conditions in none of the studied variables (P>0.05). Total urine protein after exercise insignificantly increased for both conditions (P>0.05). In contrst, urine creatinine after exercise significantly increased for both conditions (P<0.05). Protein to creatinine ratio in the sample urine also insignificantly increased in both conditions (P>0.05). These variations were not correlated to the hypoxia and normoxia conditions. Evaluation of 24 h protein excretion had a physiologic range and was distant from pathologic and nefrotic proteinuria ranges.

[Kohanpour MA, Boostani MH, Manshadi MA, Avanaki MN, Mirsepasi M, Zare AH, Peeri M, Boostani MA, Kohanpour M. **Protein to Creatinine Ratio in Urine of Young Male Soccer Players in Response to Aerobic Activity at the altitude of 2500 Meter above the Sea Level.** *J Am Sci* 2012;8(11):1-7]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 1

Keywords: Proteinuria; Hypoxia; Aerobic activity; Protein to creatinine ratio; altitude

1. Introduction

Football is among the most popular sports in the world and this issue necessitates doing more research on young soccer players.

Excessive or abnormal excretion of protein in urine is a renal failure called proteinuria. Proteinuria is one of the symptoms for other important diseases like diabetes, hypertension, cardiovascular disorders and renal diseases and can gradually destroy kidneys (Poortmans 1985). Sports proteinuria which often occurs after bodily activities and is more common in more intensive activities is a mild and reversible process which is not accompanied by clinical symptoms (Poortmans ; Ouchinsky 2006). After intensive physical activities, protein excretion in urine increases (Kocer et al. 2008). Urinary disorders resulted from sports activities were first reported in 1878 by reporting proteinuria among soldiers with intensive physical activities (Von leubo 1878). Variation in permeability of glomerular membrane with respect to proteins and variations in kidney hemodynamics during exercise are among the mentioned factors which increase protein excretion (Poortmans 1988). During exercise, renal plasma flow decreases; this is directly related to the intensity of activities. In this process, it seems that the activity of sympathetic nerves and also hormonal systems are also involved. Followed by decrease of renal blood flow during exercise, glomerular filtration rate (GFR) also decreases (Poortmans 1984). Algea ; Parish (1958) reported that most of the athletes participating in different sports activities including contact and non-contact activities suffered from protein excretion from urinate and the soccer players were not an exception. Poortmans ; Vancalck (1978) reported increase in different proteins following an intensive and short-term activity. They reported increase in total amount of protein after physical activities along with increase in their renal clearance. Carroll ; Temte (2000) reported that proteinuria was a common phenomenon among adults during activities and benign and safe factors of causing proteinuria included fever, intensive physical activity, dehydration, stress and acute diseases.

Proteinuria can be affected by different environmental factors. Effect of altitude above the sea level on proteinuria is not still well-established. Some studies have reported significant increase (Winterborn et al. 1987) in proteinuria under hypoxia condition while others have reported insignificant change (Soylu et al. 2007). What is obvious is that, in order to have an exact conclusion and present a clear statement in this regard, numerous studies and experiments should be conducted. Renal variations in response to altitude have not been investigated in detail. Proteinuria in high altitudes has been predicted by Arnold Pines which was continued by British physiologists in mountains of that area (Pines 1978). It has been said that proteinuria sometimes emerges in laboratory tests of people working in aviation (Kinra et al. 2008). This has been known that patients exposed to hypoxia suffer from glomerulomegaly, glomerulosclerosis and proteinuria (Cogo et al. 2003; Dittrich et al. 1998).

Proteinuria is a kind of body response to high altitude and it has been claimed that hypoxia disturbs performance of the kidneys (Pines 1978). Protein excretion in urine is an unstable stage with the half-time of about 1 h and the maximum rate of protein excretion happens in the first 20 to 30 min after the activity (Poortmans ; Ouchinsky 2006). Also, quantity detection of proteinuria requires collecting urine for 24 h. But, urine collection for 24 h is often very difficult and can have some errors (Sandeep et al. 2004). Protein to creatinine ratio in urine is known as a very quick and reliable way of estimating different proteinuria ranges (Shastri et al. 1994). The obtained results which are reported as ratios of protein to creatinine are substitutes for 24-hour urine sample (Ginsberg et al. 1983; Schwab et al. 1987).

Analysis of the results of the studies shows a significant correlation between protein to creatinine ratio in a random urine sample and 24-h urine protein among patients. Neithardt et al. (2002) demonstrated that a correlation with coefficient of 0.93 between 24-h urine protein excretion and protein to creatinine ratio. Yamasmit et al. (2003) also reported a 0.92 correlation coefficient between the two variables. This indicated a strong relationship between protein to creatinine ratio in a random urine sample and 24-h proteinuria (Robert et al. 1997). Therefore, protein to creatinine ratio in a random urine sample can be a substitute for the time-consuming 24-h urine protein collection. In this article, this ratio was used to evaluate 24-h proteinuria.

The purpose of this study was to compare effect of aerobic activity under two normoxia (altitude of 1200 m) and hypoxia (altitude of 2500 m) on total protein, creatinine and protein to creatinine ratio among young soccer players.

2. Material and Methods:

Participants

10 young male soccer players who had played in Fars Province Soccer League in the past three years were selected using Convenience Sampling; they signed a consent form and performed examinations and clinical tests. They were non-smokers who did not have any acute renal, hepatic, heart and other diseases, did not undergo any surgeries in the past 3 months and did not have any medicinal therapy. In fact, they were healthy and athletic people who had regular exercises for at least 3 and at most 6 days per week. None of them were a player with the performance of superior than that of Fars Soccer League, say national Soccer League or National team, and none of them were inferior to the level of Fars Soccer league. First, they were fully informed about the procedures and method of research. Then, using a personal questionnaire, the information including age, gender, sports background and so on were obtained and they signed a written consent form and healthiness of their kidney and urine tracts was approved by a physician.

Characteristics of the participants are summarized in Table 1.

Exercise Program

On the first day, the participants' aerobic power was measured on a treadmill using Bruce protocol under physician supervision (Maud ; Foster 1995). After 48 h of resting, the participants participated in their first exercise session. They had two sessions of aerobic exercises including 30 min of running at three different intensities and two different conditions with regard to partial pressure of oxygen. The resting interval between the two sessions was 48 h.

To avoid misleading results caused by the disturbing effect of exercise sessions on each other, the participants were divided into two groups; on the first day, one group did the exercise under normoxia condition while the other group performed under hypoxia condition. On the second day, the situation was the other way round. The latter case was determined on a random basis.

Each participant completed running on the treadmill for about 30 min with 70% of his maximal heart rate once under normoxia (altitude of 1200 meters) condition and another time under hypoxia condition (altitude of 2500 meters). The maximal heart rate was calculated using the following relation 208-(0.7 age) (Tanaka et al. 2001). Hypoxia condition with oxygen percentage of 15.5% was equivalent to the altitude of 2500 m above the sea level, which was provided by Go2 altitude device made in Australia which was at the laboratory of School of Physical Education and Sports Science, Tehran Shahid Beheshti University (Boning 1997).

The participants rested in the houses which were specifically provided for them during the experiment and they were asked to avoid any physical activity. Also, they were asked to avoid foods which had high amount of protein, fat and caffeine at the night before the sampling day. In the morning of the sampling day, they emptied their bladder and then rested in the sitting position in a suitable location without any physical activity and arrived at the exercise laboratory 2 h before starting. On the sampling day, they also drank enough water to have sufficient urine for the sampling before and after the exercises.

Data Collection and Analysis of the Urine Sample

Urine samples were taken from the participants before and 20 min after the exercise. The samples were kept in special containers at temperature of 4 degree Centigrade and the samples were delivered to laboratory at most 30 min after the sampling in both two sessions. In this study, urinary total protein and creatinine were measured and analyzed. Concentration of urinary total protein was analyzed by Elisa Coomassie blue or Bradford method using diasorin kit made in USA with the sensitivity of 1 mg in dl and concentration of urinary creatinine was analyzed by spectrophotometry method based on Jaffe model using diasorin kit made in USA with the sensitivity of 31 mg in dl. Protein to creatinine ratio of urine was also calculated by dividing each sample's protein by creatinine based on mg in dl unit.

Statistical Method

First, in order to ensure normality of the distribution and to determine parametric or non-parametric statistical test, Kolmogorov–Smirnov test was used to analyze the obtained data and it was proven that the data had normal distribution. Thus, to investigate variations of variables between the two exercise sessions under normoxia and hypoxia conditions and also to investigate variations of variables within each running session, T-student test specific for dependant groups were used. SPSS version 16 statistical software was used to carry out statistical calculations.

3. Results

The amounts of urinary total protein, creatinine and protein to creatinine ratio before and after all 2 exercise sessions are summarized in Table 2.

Table 3 shows statistical results for T-student test specific for dependent groups between the two exercise sessions.

Table 4 demonstrates the results of t-student test specific for dependent groups for each exercise session.

As can be seen in Table 3, no significant difference existed between normoxia and hypoxia conditions in any of the studied variables ($P>0.05$).

According to the results of this study, total urinary protein increased after exercises in both normoxia and hypoxia conditions but this increase was not significant ($P>0.05$). On the contrary, urine creatinine significantly increased in both normoxia and hypoxia conditions ($P<0.05$). Protein to creatinine ratio in urine had an insignificant decrease in both conditions ($P>0.05$).

4. Discussion

In the present study, the amount of urinary total protein and creatinine after 20 min of aerobic exercise under normoxia and hypoxia conditions did not show any significant difference from each other. This was in contrast with the results of Winterborn et al. (1987) which showed a significant increase in proteinuria at high altitudes. They stated that difference in proteinuria at high altitudes was closely related to degree of hypoxia.

This contradiction in the results might be due to the present study's 2500 m above the sea level versus their 3000 m altitude above the sea level. In this regard, Soylu et al. (2007) also did not observe any significant difference in proteinuria and creatinine clearance at the altitude of 1200 m above the sea level among mice. At high altitude, an increase in capillary permeability with secondary hypoxia stress might lead to one bar larger filter (Winterborn et al. 1987).

Hypoxia is a conventional mechanism in the progress of different renal diseases which leads to total increase in glomerular permeability and, as a result, proteinuria emerges (Fine et al. 2000; Hensen et al. 1994; Jefferson et al. 2002).

Anyway, the current results did not support this theory. These results must be investigated at higher altitudes and there are incompatible results in this regard. The results of the present study were in good agreement with the results of Soylu et al. (2007) and were in opposition to the results of Winterborn et al. (1987). Nevertheless, if degree of hypoxia in the present study was equivalent to the altitude of 3000 m above the sea level instead of 2500 m, the results might be in agreement with the results of Winterborn et al. (1987). At the height 3000 m or more, renal blood flow and Glomerular Filtration Rate decreases (Pines 1978). Pines (1978) observed that 7 volunteers who were in eastern African Mountains for 6 weeks and went to 5 different altitudes during this period, concentration of proteinuria in the morning urine sample increased at the first two altitudes and decreased in the three remaining altitudes.

Although this is in contrast with the relation of proteinuria to the increased hypoxia, it seems to be related to the adaptation of kidney to the new environment in the given altitude (Pines 1978).

Since proteinuria did not happen at moderate altitudes during sports activity, probably higher altitude was needed for a significant proteinuria response (Pines 1978). A correlation has been demonstrated between both proteinuria and altitude, and glomerular permeability and partial pressure of oxygen, and this increase can be reduced by returning from the altitudes or oxygen therapy (Kömürcüog et al. 2003; Winterborn et al. 1987; Rennie et al. 1970). Rennie et al. (1971) reported that proteinuria concentration among adult males who were born and still living at high altitudes was higher than those compared with those who had moved to sea level. Acute hypoxia seems to be a way of losing protein through urine (Rennie et al. 1971). Results of hypoxia at high altitudes showed a total increase in glomerular capillary permeability, leading to proteinuria and preventive behaviors of angiotensin-converting enzyme, which causes proteinuria among people living at high altitudes (Soylu et al. 2007; Plata et al. 2002). Hypoxia can play a role in permeability of capillary endothelial (Cogo et al. 2003).

In-vivo experiments have shown that exposing endothelial cells to low oxygen concentration causes small and large intracellular cracks. This phenomenon is reversible (Cogo et al. 2003).

Table 1: Characteristics of the participants

Age (year)	**Weight (kg)**	**Height (cm)**	**VO_2max (ml/kg/min)**	**BMI (kg/m^2)**
18 ± 0.5	64.42 ± 3.6	174 ± 4	47.6 ± 4.8	21.27 ± 2.1

Table 3: Statistical tests of T-student test specific for dependent groups between two sessions of activity

Variable	**Time of exercise**	**t**	**df**	**P**
Total Protein	Before	0.728	9	0.485
	Afrer	1.964	9	0.081
	D	0.318	9	0.758
Creatinine	Before	1	9	0.343
	Afrer	0	9	1
	D	0.361	9	0.726
Protein to Creatinine Ratio	Before	1.071	9	0.312
	Afrer	1.404	9	0.194
	D	1.212	9	0.256

D: Average difference of before and after activities (Delta)

Table 4: Statistical results of T-student test specific for dependent groups for each exercise session

Variable	**Exercise Session**	**t**	**df**	**P**
Total Protein	Normoxia	1.440	9	0.184
	Hypoxia	1.405	9	0.194
Creatinine	Normoxia	3.284	9	0.009 *
	Hypoxia	3.321	9	0.009 *
Ratio	Normoxia	0.650	9	0.532
	Hypoxia	0.648	9	0.533

* The mean difference is significant at the 0.05 level

Table 2. Mean and standard deviation of proteinuria before and after exercise sessions

Variable	Total Protein (mg/dl)		Creatinine (mg/dl)		Protein to Creatinine Ratio	
Session	pre	post	pre	post	pre	post
Normoxia	2.72 ±2.32	4.58 ±2.87	95.50 ±55.65	188.5 ±51.31	0.031 ±0.026	0.024 ±0.018
Hypoxia	2.77 ±2.42	4.61 ±2.88	96 ±55.71	188.5 ±51.15	0.032 ±0.029	0.025 ±0.019

Patients with respiratory failure seem to have a significant increase in their proteinuria compared with other patients without respiratory failure (Cogo et al. 2003). According to the observation of proteinuria in this acute phenomenon, continuation of hypoxia can lead to the decrease in total protein serum (Cogo et al. 2003). Hensen et al. (1994) claimed that acute altitude hypoxia increases proteinuria excretion under the mechanism of increasing glomerular permeability without any change in tubular function. Kayser et al. (1992) reported that tubular difference at altitudes higher than 5000 m above the sea level was not significant with respect to that at the sea level. But, if sports intensity increases, tubular reabsorption and oxygen consumption might decrease with lower glomerular filtration (Luks et al. 2008). Therefore, in order to complete the current research, more investigations are required with higher intensities. Intense hypoxia leads to intense activity of sympathetic nerve system (Luks et al. 2008).

In patients with chronic obstructive pulmonary disease, levels of arterial natriuretic peptide and glomerular permeability increase (Kömürcüog et al. 2003). In the present study, aerobic exercise with the intensity of 70% maximal heart rate lacked enough intensity to significantly affect total proteinuria and this was not related to normoxia and hypoxia conditions. Von leubo (1878), Poortmans ; Vancalck (1978), De Paolo et al. (2002) and Turgut et al. (2003) showed that proteinuria excretion increased after sports activity, which seemed to be related to renal clearance (Poortmans ; Vancalck 1978). Also, in the present study, level of urine creatinine significantly increased after running with the intensity of 70% maximal heart rate in both conditions. Turgut et al. (2003) observed a significant increase in urine creatinine concentration for both male and females after sports activity. Renal arterials constriction resulting from increase in epinephrine and norepinephrine during sports can be an increasing factor of proteinuria after sports (Poortmans 1984). Followed by decrease in renal blood flow during sports, glomerular filtration rate also decreases and, because this decreases is lower than renal blood flow, filtration fraction increases and thus passage of proteins with higher molecular weight through glomerular membrane is facilitated (Poortmans 1984). Increase in plasma renin activity which can be seen during intensive sports activities and is resulted from the stimulation of glomerular sympathetic system can be effective in proteinuria after sports activity (Poortmans 1985; Creeth et al. 1963).

Interference of kallikrein as an enzyme from kinin system which has a close relationship with Rennin-Angiotensin can also increase glomerular permeability. Secreted enzymes from kinin system in urine show an increase in their activity during participation of healthy people in activities that can lead to proteinuria. Loss of constant negative charge of capillary wall can have a role in this regard (Poortmans 1985; Creeth et al. 1963). Zambraski et al. (1981) analyzed variations of renal ciallic acid in relationship with sports and pointed out that sports decreases glomerular electrostatic barrier and can justify a part of increase in glomerular macromolecules transfer.

Role of factors such as prostaglandins is also important and, if the athletes are given drugs to block production of prostaglandins, sports proteinuria considerably decreases in the absence of any variations of renal hemodynamics (Feldt et al. 1985). Recent cases must be measured in future studies to help better interpretation. Gunduz et al. (2007), Senturk et al. (2007) and Kocer et al. (2008) showed an increase in proteinuria after sports activity. Findings of Poortmans ; Vancalck (1978) and Clerico et al. (1990) demonstrated that sports proteinuria was quickly reversible ; thus, it is recommended for future studies to frequently measure proteinuria excretion after exercise.

Although the most effective factor in proteinuria is the intensity of exercise (Poortmans ; Vancalck 1978; Kramer et al. 1988), duration of exercise is another effective factor (Clerico et al. 1990; Boileau et al. 1980). Thus, probably, if the intensity and duration of exercises were higher in the present experiment, this difference between normoxia and hypoxia conditions was not observed.

Using this ratio accelerates and starts therapeutic considerations. Superiority of protein to creatinine ratio of the random sample has been confirmed for estimating 24-h proteinuria (Kristal et al. 1988). Kristal et al. (1988) found a considerable linear relationship between 24-h proteinuria and protein to creatinine ratio. It was concluded that protein to creatinine ratio for evaluating 24-h quantity of proteinuria was a reliable substitute and was extensively more practical (Kristal et al. 1988). Protein to creatinine ratio of less than 0.1, between 0.1 and 1 and more than 1 can be used to detect physiological, pathological and nephrotic ranges, respectively (Kristal et al. 1988). It has been also said that the ratio of less than 0.2 indicates normal proteinuria and the ratio of more than 3.5 shows the nephrotic range of proteinuria (Sandeep et al. 2004). Therefore, protein to creatinine ratio can be used for detecting the significance of proteinuria (Saikul et al. 2006).

5. Conclusion

Based on the results obtained in this study, no significant difference existed between the values of urinary protein to creatinine ratio after 20 min in two sessions of exercise under normoxia and hypoxia conditions. Also, none of the exercise sessions had any significant effect on this ratio. The present findings demonstrated protein to creatinine ratio of less than 0.1 for the samples after and before two sessions of activity. Therefore, in this study, 24-h proteinuria after physical exercises in this study had a physiologic range and was distant from pathologic and nephrotic ranges; thus, it was not harmful (Kristal et al. 1988). In fact, all the participants in the present experiment had the ratio of less than 0.1 in all their samples. Anyway, in order to have a more exact conclusion, more investigations are required.

Corresponding Author:

Mohammad Ali Kohanpour
Department of Exercise Physiology
Central Tehran Branch, Islamic Azad University
Tehran, Iran
E-mail: mkohanpur@gmail.com

Reference

1. Algea, E.P., and H.H. Parish, 1958: Renal response to exercise: urinary findings. *JAMA*, **167**, 807-813.
2. Boileau, M., E. Fuchs., J.M. Barry., and C.V. Hodges, 1980: Stress hematuria: athletic pseudonephritis in marathoners, *Urology*, **15**(5): 471-474.
3. Boning, D., 1997: Altitude and hypoxia training-Int, *J Sport Med*, **18**:565-570.
4. Carroll, M.F., and J.L. Temte, 2000: Proteinuria in adults: a diagnostic approach. *Am Fam Physician*, **62**: 1333-40.
5. Clerico, A., C. Giammattei., L. Cecchini., A. Lucchetti., L. Cruschelli., G. Penno., G. Gregori., and O. Giampietro, 1990: Exercise-induced proteinuria in well-trained athletes, *Clinical Chemistry*, **36**: 562-564.
6. Cogo, A., A. Ciaccia., C. Legorini., A. Grimaldi., and G. Milani, 2003: Proteinuria in COPD patients with and without respiratory failure, *Chest*, **123**: 652-653.
7. Creeth, J.M., R.A. Kekwick., F.V. Flynn., H. Harris., and E.B. Robson, 1963: An ultracentrifuge study of urine proteins with particular reference to the proteinuria of renal tubular disorders, *Clin Chim Acta*, **8**: 406.
8. Dittrich, S., N.A. Haas., C. Buhrer., C. Muller., I. Dahnert., and P.E. Lange, 1998: Renal impairment in patients with long-standing Cyanotic congenital heart disease, *Acta Paediatr*, **87**: 949-954.
9. De Paolo, E.F., R. Gatti., F. Lancerin., E. Cappellin., G. Solda., C.B. DePaolo., and P. Spinella, 2002: Urinary insulin-like growth factor I in athletes before and after physical exercise and in sedentary subjects, *Clin Chim Acta*, **322**:51-57.
10. Feldt-Rasmussen, B., L. Baker., and T. Deckert, 1985: Exercise as a provocative test in early renal disease in type 1 (insulin-dependent) diabetes: albuminuric, systemic and renal haemodynamic responses. *Diabetologia*, **28**: 389-96.
11. Fine, L.G., D. Bandyopadhay., and J.T. Norman, 2000: Is there a common mechanism for the progression of different types of renal diseases other than proteinuria? Towards the unifying theme of chronic hypoxia, *Kidney Int. (Suppl),* **75**: S22-S26.
12. Ginsberg, J.M., B.S. Chang., R.A. Matarese., and S. Garella, 1983: Use of single voided urine samples to estimate quantitative proteinuria, *N Engl J Med,* **309**:1543-6.
13. Gunduz, F., O. Kuru., and U.K. Senturk, 2003: Effect of nitric oxide on exercise-induced proteinuria in rats, *J Appl Physiol*, **95**: 1867-1872.
14. Hensen, J.M., N.V Olsen., B. Feldt-Rasmussen., I.L. Kanstrup., M. Dechaux., C. Dubray., and J.P. Richalet, 1994: Albuminuria and overall capillary permeability of albumin in acute altitude hypoxia, *J Appl Physiol,* **76:** 1922-1927.
15. Jefferson, J.A., E. Escudero., M.E. Hurtado., J.P. Kelly., E.R. Swenson., M.H. Wener., M. Burnier., M. Maillard., G.F. Schreiner., R.B. Schoene., A. Hurtado., and R.J. Johnson, 2002: Hyperuricemia, hypertension, and proteinuria associated with high-altitude polycythemia, *Am J Kidney Dis,* **39**: 1135-1142.
16. Kayser, B., K. Acheson., J. Decombaz., E. Fern., and P. Cerretelli, 1992: Protein absorption and energy digestibility at high altitude, *J Appl Physiol,* 73: 2425-2431.
17. Kinra W. C.P., D. Rich., W.C.V. Singh., and G.C.G. Gomez, 2008: Proteinuria in Indian aviators, *IJASM,* **52**(2): 44-53
18. Kocer, G., U.K. Senturk., O. Kuru., and F. Gunduz, 2008: Potential sources of oxidative stress that induces post-exercise proteinuria in rats. *J Appl Physiol*, **10**:1152-1176.
19. Kömürcüog˘ lu A., S. Kalenci., D. Kalenci., B. Kömürcüoglu., and G. Tibet, 2003: Microalbuminuria in chronic obstructive pulmonary disease, *Monaldi Arch Chest Dis*, **59**(4): 269-272.
20. Kramer, B.K., M. Kernz., K.M. Ress., M. Pfohl., G.A. Muller., R.M. Schmullijng., and T. Risler, 1988: Influence of strenuous exercise on albumin excretion, *Clin Chem*, **34**(12): 2516-2518.
21. Kristal, B., S.M. Shasha., L. Labin., and A. Cohen, 1988: Estimation of quantitative proteinuria by using the protein/creatinine ratio in random urine samples, *Am J Nephrol*, **8**(3): 198-203.
22. Luks, A.M., R.J. Johnson., and E.R. Swenson, 2008: Chronic kidney disease at high altitude, *J of the Am Soc of Nephro*, 1-10.
23. Maud, P.J., and C. Foster, 2006: Physiological assessment of human fitness, 2nd ed. *Champaign, il: human kinetic Publishers,* 19-39.
24. Neithardt, A.B., S.L. Dooley., and J. Borensztajn, 2002: Prediction of 24-hour protein excretion in pregnancy with a single voided urine protein-to-creatinine ratio, *Am J Obstet Gynecol,* **186**(5): 883-6.

25. Pines, A., 1978: High-altitude acclimatization and proteinuria in east Africa, *Br J Dis Chest*, **72**: 196-198.
26. Plata, R., A. Cornejo., C. Arratia., A. Anabaya., A. Perna., B.D. Dimitrov., G. Remuzzi., and P. Ruggenenti, 2002: Commission on global advancement of nephrology (COMGAN), Research subcommittee of the international society of nephrology. Angiotensin-converting-enzyme inhibition therapy in altitude polycythaemia: a prospective randomized trial, *Lancet*, **359** (9307): 663-666.
27. Poortmans, J.R., and B. Vancalck, 1978: Renal glomerular and impairment during strenuous exercise in women. *Eur J Clin Invest*, **8**(3) 175-178.
28. Poortmans, .J.R., 1984: Exercise and renal function. *Sport Med*, **1**(2): 125-153.
29. Poortmans, J.R., 1985: Postexercise proteinuria in humans: facts and mechanisms. *JAMA*. **253**, 236-240.
30. Poortmans, J.R., 1988: Evidence of increased glomerular permeability to proteins during exercise in healthy man. *Contrib Nephrol*, **68**: 136-140.
31. Poortmans, J.R., and M. Ouchinsky, 2006: Glomerular filtration rate and albumin excretion after maximal exercise in aging sedentary and active men, *J of Biol Sci and Med Sci*, **61**, 1181-1185.
32. Rennie, I.D., and B.J. Joseph, 1970: Urinary protein excretion in climbers at high altitudes. Lancet, 1:1247-51.
33. Rennie, D., E. Marticorena., C. Monge., and L. Sirotzky, 1971: Urinary protein excretion in high-altitude residents. *J of Appl Physiol*, **31**: 257.
34. Robert, M., F. Sepandj., R.M. Liston., and K.C. Dooley, 1997: Random protein-creatinine ratio for the quantitation of proteinuria in pregnancy, *Obstet Gynecol*, **90**(6): 893-5.
35. Saikul, S., B, Wiriyasirivaj., and P. Charoenchinont, 2006: First 4-hour urinary protein - creatinine ratio for diagnosis of significant proteinuria in preeclampsia, *J Med Assoc Thai*, **89** (Suppl 4): S42-6.
36. Sandeep, G., G.A. Kumar., R. Anurag., and S.K. Sharma, 2004: Evaluation of random urine sample orotein-cretinine ratio as an index of quantitative proteinuria, JK Science, **6**(3): 134-137.

8/22/2012