Original Article

Effects of aerobic exercise on blood glucose in continuous ambulatory peritoneal dialysis patients

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Abstract

Background: Peritoneal dialysis has a number of complications including increased blood glucose. Although exercise has been suggested to resolve this complication, most patients are not active. The present study aimed at determining the effects of twice-weekly, 40-min sessions of pedaling on a stationary bicycle on mean fasting blood sugar (FBS) and 2-h postprandial blood sugar (PPBS) among continuous ambulatory peritoneal dialysis patients.

Materials and Methods: In this clinical trial, convenience sampling was used to select 22 patients [age: 51.4 (12.3) years] undergoing continuous ambulatory peritoneal dialysis [mean duration: 12.5 (8.5) months] from university hospitals in Isfahan, Iran. The subjects were randomly divided into two groups (test and control). The test group participated in an 8-week exercise program in which they pedaled a stationary bicycle with an intensity of four on Borg Scale of Perceived Exertion. FBS and PPBS were measured at baseline and at the end of the 8th and 16th sessions of exercise. Data were analyzed with Student's *t*-test and repeated measures analysis of variance.

Results: After the eighth session, the mean FBS and PPBS levels were lower in the test group than in the control group. However, the differences were not statistically significant. After 16 sessions of exercise, the mean FBS and PPBS levels in the intervention group were significantly less than the in control group.

Conclusions: Forty minutes of pedaling on a stationary bicycle for two times a week can significantly reduce mean FBS and PPBS levels in continuous ambulatory peritoneal dialysis patients.

Key words: Aerobic exercise, blood glucose, continuous ambulatory peritoneal dialysis, Iran, nurses

Introduction

The global prevalence of end-stage renal disease is increasing and predicted to reach 1200 cases per million population by 2020.[1] Iran is no exception, since the incidence of new cases of the disease increases at an annual rate of 22.6% with 4000 new cases reporting every year.[2] In an individual with end-stage renal failure, renal function is lower than 10% of its normal value and kidney treatments (renal transplantation, hemodialysis, and peritoneal dialysis) are indispensable to save the patient's life.[3] Although these therapies can significantly increase patient survival, they may cause multiple complications.[4]

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Continuous ambulatory peritoneal dialysis is the most common type of peritoneal dialysis.[5] In peritoneal dialysis, glucose is added to the dialysate to create a higher gradient during the process of osmosis.[6] Since the peritoneum is a semipermeable membrane, 50-80% of the glucose is absorbed.[7] Therefore, the peritoneal glucose concentration will increase to about 15-40 times its physiological level. This will not only increase blood glucose, but also lead to changes in the peritoneal membrane structure. Such changes include vasculopathy, thickening of the peritoneal membrane, and reduced ultrafiltration (a vital function in renal patients).[8] Consequently, metabolic complications due to excessive calorie intake and the subsequent weight gain, and increased blood glucose are among the side effects of peritoneal dialysis.[9] As the latter two complications, either alone or in combination, are found in 84% of peritoneal dialysis patients, metabolic control in these patients requires a comprehensive strategy.[10] As the resulting physical inactivity and exacerbation of cardiovascular problems account for a large proportion of mortality in dialysis patients,[11] most researchers recommend exercise to reduce these side effects.[12] While the researchers believe that exercise facilitates muscle glucose uptake and thus lowers blood glucose levels,[13] the majority of patients undergoing peritoneal dialysis do not have physical activity and cannot enjoy improved glycemic control.[14]

Lack of adequate encouragement for the patients, inaccessibility of sports sites,[15] and problems caused by the pathophysiology of the disease are among the barriers to exercise.[16] Despite the various obstacles to motivating patients to exercise,[17] a proper exercise program will undoubtedly contribute to better control of their blood glucose levels. Numerous studies worldwide have evaluated the effects of exercise on blood pressure, heart function, adequacy of dialysis, quality of life, and urea and albumin levels in hemodialysis patients.[18-20] They have mostly used training protocols including 30–60 min of pedaling on stationary bicycles for two to three times a week during courses of 6 weeks to 12 months. Borg Scale of Perceived Exertion is the most commonly employed method to determine exercise intensity.[21]

Patients undergoing peritoneal dialysis refer to hospitals less frequently than do hemodialysis patients. It is thus more difficult to persuade the first group to attend a fitness center. This means that individual sports or exercises that can be done at home or workplace have to be considered in designing an exercise program for these patients.[22] Moreover, these patients will need accessible, affordable, safe, and easy-to-use exercise equipment that suits their physical conditions.[23] Accordingly, being small, safe, and portable makes stationary bicycle a good choice for individuals who cannot exercise outside their home. Pedaling on a stationary bicycle increases the patient's aerobic capacity,[13] while enabling him/her to constantly monitor his/her cardiac function and blood pressure during exercise. Besides, working out in a sitting position helps patients with orthopedic limitations, balance disorder, and orthostatic blood pressure change use the equipment.[24]

Cycling and walking are both aerobic exercises. Research about the effects of aerobic exercise on blood glucose in diabetic patients has reported contradictory results. Shivananda *et al*. found that 6 weeks of aerobic exercise (walking on treadmill) significantly decreased fasting and 2-h postprandial blood glucose levels in diabetic patients.[25] Similarly, Chiyan *et al*. showed 12 weeks of treadmill exercise to significantly decrease fasting blood glucose in continuous ambulatory peritoneal dialysis patients.[26] In contrast, Micaus *et al.* reported that 7 days of treadmill exercise did not affect fasting blood glucose in type II diabetics.[24]

In their attempt to control the complications of peritoneal dialysis, nurses are required to promote healthy lifestyle[6] and encourage patients to exercise.[16] However, few studies have assessed the effects of exercise on peritoneal dialysis patients. In addition, there is no agreement about a safe and accessible exercise for these patients.[27] Considering the need for broader studies in this field,[28] we consulted a nephrologist about the safety of stationary bicycles for the mentioned group of patients and designed a study to investigate the effects of aerobic exercise with this equipment on mean fasting and 2-h postprandial blood glucose levels in patients undergoing continuous ambulatory peritoneal dialysis.

Materials and Methods

This clinical trial was conducted for 2 months in 2011. After the research project was approved by the ethical committee of the university and research permission was issued in nursing and midwifery, sampling was started. A total of 22 continuous ambulatory peritoneal dialysis patients were selected from Alzahra and Ali Asghar hospitals (Isfahan, Iran) through convenience sampling. The inclusion criteria were: age above 18 years, at least 3 months of having undergone peritoneal dialysis,[26] and being dialyzed with dialysates containing 1.5% glucose. Individuals with ischemic disease or diagnosis of angina in the past 6 months, pulmonary disease requiring oxygen therapy, stroke or transient ischemic attack within 3 months before the study, any musculoskeletal disorder preventing physical activity,[19] blood pressure ≥180/110 mmHg or systolic blood pressure ≤90 mmHg,[28] evidence of peritonitis, body temperature greater than 37.8°C,[29] and diabetes were not included. Hospitalization for any reason, changes in the type of dialysate, symptoms suggestive of peritonitis, and receiving insulin or hypoglycemic tablets during the course of the study were the exclusion criteria.

The selected patients were explained about the objectives of the study and asked to sign written informed consent forms. Then, they were randomly divided into two groups of 11 each (test and control groups) [Table 1]. The intervention group participated in an 8-week aerobic exercise program[18] comprising two 40-min sessions of pedaling on an electric stationary bicycle (made in Taiwan) per week. The sessions were held between 8 a.m. and 12 p.m. in a quiet ventilated place with sufficient light while the patient had comfortable clothing on. Before each session, the patient relaxed on a chair with back support for 5 min. The spine was in neutral position and no pressure was exerted on the abdomen during this time. After blood pressure and temperature control, the exercise started only if blood pressure was less than 180/110 mmHg, systolic blood pressure was more than 90 mmHg, and temperature was less than 37.8°C.

The active phase of exercise (30 min of pedaling) was preceded and followed by 5 min of static stretching of lower extremities and adjusting the bicycle at 35 rounds

Table 1: Demographic and disease-related characteristics of continuous ambulatory peritoneal dialysis patients in the two groups

Characteristics	Test group (*n*=11)	Control group (*n*=11)	*P*	Statistical test
Female/male	2/9	3/8	0.50	Fisher's exact test=1
Age (years)	50.5 (14.3)	52.3 (10.3)	0.74	t=0.32
Duration of peritoneal dialysis (months)	12.1 (8.1)	13.0 (8.9)	0.77	t=0.29
Cause of renal failure			0.54	χ^2=4.98
Hypertension	5	2		
Glomerulonephritis	1	2		
Polycystic kidney	1	1		
Urinary reflux	1	0		
Renal artery stenosis	1	1		
Nephrotic syndrome	1	1		
Unknown	1	4		

Values are either number of participants or mean (SD)

per minute (warm up and cool down, respectively). Since the subjects were not ready for intense physical activity, an increasing exercise program was employed, i.e. the first session included 5 min of warm up, 15 min of pedaling with an intensity of 4 on the 10-point Borg Scale of Perceived Exertion, and 5 min of cool down. The pedaling time was increased to 30 min from the second session and then kept constant until session 16.[13,27] At 5-min intervals during the active phase, the patients were asked about exercise intensity and allowed to adjust the bicycle in order to maintain an unchanging intensity (level 4).

Using a sphygmomanometer, the participants' blood pressure was measured at the 10th, 20th, and 30th minutes of the active phase. Pedaling was stopped if the patient's blood pressure exceeded 220/110 mmHg or decreased by 20 mmHg compared to the previous measurement in the same session. It was also discontinued by patient request and in case of dizziness, loss of consciousness or vision, speech problems, any evidence of cardiac ischemia (chest pain, shortness of breath), and damage to the bicycle. The intervention was resumed only if the problem was resolved within 24 h. Otherwise, the subject was withdrawn from the study.[30]

At the beginning of the study, a glucometer (Bionime, Switzerland) was used to assess the patients' mean blood sugar levels after 6 h of fasting, 2 h after a meal, and 2 h after breakfast, which was identical for all subjects. The measurements were repeated after 8 and 16 sessions of intervention and the results were compared.

Due to convenience sampling and random assignment of the subjects, the test and control groups were similar as much as possible. On the other hand, Kolmogorov–Smirnov test confirmed the normal distribution of variables. Therefore, parametric tests were used for data analysis. Independent *t*-tests were applied to determine between-group differences in the mean fasting blood sugar (FBS) and 2-h postprandial blood sugar (PPBS) levels before and after the 8th and 16th sessions of the intervention. Within-group differences in fasting and 2-h postprandial blood glucose levels were investigated with repeated measures analysis of variance (ANOVA). The level of significance was set at $P < 0.05$ in all analyses. All analyses were performed in SPSS for Windows 18.0 (SPSS Inc., Chicago, IL, USA).

Results

All the 22 participants (11 in the test group and 11 in the control group) completed the study without any problem. The two groups had no significant differences in demographic characteristics including age, gender, duration of dialysis, and underlying cause of renal failure [Table 1].

At baseline, the mean (SD) FBS levels were 118.5 (9.0) mg/dl in the test group and 117.8 (15.5) mg/dl in the control group. The corresponding values were 108.2 (14.3) and 117.2 (15.1) mg/dl, respectively, after 8 sessions of exercise and 93.6 (12.5) and 117.4 (15.4) mg/dl, respectively, after 16 sessions (at the end of the study). While the mean FBS levels of the two groups were not significantly different either before the intervention (P = 0.910) or after the 8th session (P = 0.167), significantly lower levels were observed in the test group after the 16th session (P = 0.001) [Table 2].

In addition, there was no significant difference between the test and control groups in terms of 2-h PPBS at baseline [182.4 (26.7) mg/dl vs. 183.2 (24.1) mg/dl; P = 0.940] or after eight sessions [172.2 (21.4) mg/dl vs. 181.9 (21.9) mg/dl; P = 0.305]. However, after 16 sessions of exercise, the 2-h PPBS level was significantly lower in the test group compared to the control group [162 (15.1) mg/dl vs. 182.0 (18.6) mg/dl; P = 0.010] [Table 2].

Within-group differences of FBS and 2-h PPBS levels are shown in Figures 1 and 2, respectively. As it is observed, the test group's mean FBS had a decreasing trend from baseline to the 8th and then the 16th sessions (P = 0.001). In contrast, there were no significant differences between the values in the control group (P = 0.940) [Figure 1]. Similarly, the test group's 2-h PPBS levels showed a significant reduction from baseline to the 8th session and from the 8th session to the 16th session (P = 0.006). However, no such significant change was detected in the control group (P = 0.910) [Figure 2].

Table 2: Comparison of the mean FBS and 2-h PPBS at baseline and after 8 and 16 sessions of aerobic exercise in the test and control groups

Baseline					8th session					16th session				
Variable	Groups	Mean	SD	*P*	Variable	Groups	Mean	SD	*P*	Variable	Groups	Mean	SD	*P*
FBS (mg/dl)	Test	118.0	9.0	0.91	FBS (mg/dl)	Test	108.0	14.3	0.167	FBS (mg/dl)	Test	93.6	12.5	0.001
	Control	117.0	15.5			Control	117.0	15.1			Control	117.0	15.3	
PPBS (mg/dl)	Test	182.0	26.7	0.94	PPBS (mg/dl)	Test	172.0	21.4	0.305	PPBS (mg/dl)	Test	162.0	12.5	0.01
	Control	183.0	24.1			Control	181.0	21.9			Control	182.0	18.6	

FBS: Fasting blood sugar, PPBS: Postprandial blood sugar, SD: Standard deviation

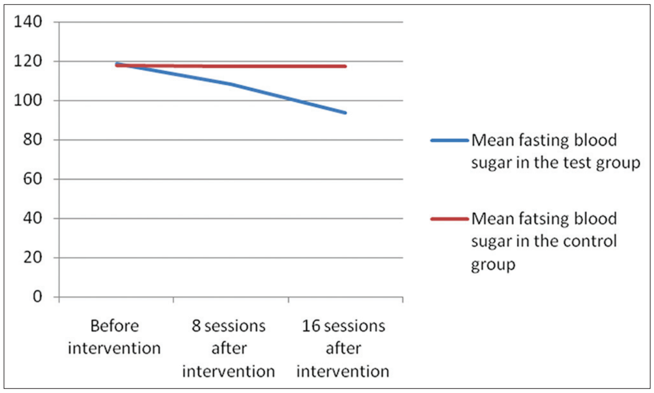

Figure 1: FBS of the subjects at baseline and after 8 and 16 sessions of aerobic exercise

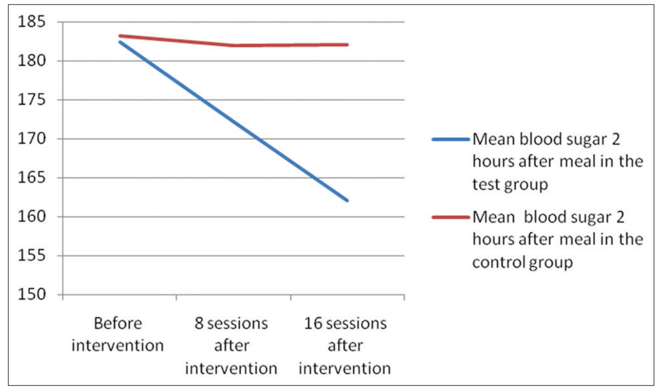

Figure 2: Two-hour PPBS at baseline and after 8 and 16 sessions of aerobic exercise

Discussion

We found no significant differences between the test and control groups in terms of the mean FBS and 2-h PPBS levels before the intervention. Moreover, the mean FBS and 2-h PPBS levels of the control group did not show significant changes throughout the study. In the test group, however, eight sessions of aerobic exercise could make statistically insignificant reductions in both the mentioned values. The reductions turned to be significant after the 16th session. Mikas *et al.* reported 7 days of aerobic exercise to have no significant effects on FBS levels and considered low number of sessions as the possible reason.[24] Generally, 40 min of pedaling on a stationary bicycle, twice weekly for 8 weeks is accepted to significantly lower FBS and 2-h PPBS levels in patients undergoing continuous ambulatory peritoneal dialysis. In a study on 16 patients undergoing continuous ambulatory peritoneal dialysis, Chi Yan *et al*. indicated that 12 weeks of treadmill workout significantly decreased the patients' mean FBS from 95.4 ± 12.6 to 90 ± 10.8 mg/dl.[26]

Walking can also be effective in controlling blood sugar. In 2011, Ahmadi and Ghajari evaluated the effects of an 8-week course of walking on blood sugar levels of 20 patients with type II diabetes. At the end of the study, they found the intervention group to have significantly lower mean FBS compared to the control group.[30] In a 6-week study, Shivanandan *et al*. examined the effects of walking on the mean blood sugar of 10 non–insulin-dependent diabetics. At the end of the study, they identified the intervention group to have significantly lesser mean FBS and 2-h PPBS levels compared to the control group. They concluded that since working muscles are more sensitive to insulin, aerobic exercise facilitates glucose uptake by the muscles, and can thus be a definitive tool in blood glucose control.[25]

Ragers,[31] Bernard,[32] Baldy and Esnoling,[33] and Isfahani[34] showed that aerobic exercise (walking and bicycle riding) can help better to control blood sugar in patients with type II diabetes. They believed that aerobic exercise increases insulin binding to the receptors of monocytes, which in turn causes higher production of insulin and thus greater glucose absorption, and finally reduces the blood sugar level. On the contrary, Mikas *et al*. reported that 7 days of aerobic exercise (walking and stationary bicycling) could not significantly decrease FBS among the studied subjects.[24] Such an inconsistency might have been due to the difference in the number of subjects, duration of exercise, and exercise program designs. Hence, further research to assess the impact of longer periods of exercise on blood sugar levels is warranted.

In continuous ambulatory peritoneal dialysis patients, impaired glucose metabolism is seen in the form of glucose intolerance, decreased peripheral insulin sensitivity, hyperinsulinemia, and hyperglycemia. Both hyperinsulinemia and hyperglycemia increase the risk of atherogenesis and hyperlipidemia, and can eventually lead to or exacerbate atherosclerotic events (either cardiovascular or cerebrovascular). Exercise is one among the interventions to control weight, blood lipids, and blood sugar in these patients. Research has confirmed that exercise enhances the capillary bed and increases the number of insulin receptors. Since working muscles are more sensitive to insulin than resting muscles, each unit of insulin will cause more glucose absorption during exercise. This reduces blood sugar, especially in mild- to moderate-intensity exercises. Thus, aerobic exercises, which are safe and easy, can increase insulin sensitivity, decrease insulin resistance, lower blood sugar, and ultimately improve the quality of life in continuous ambulatory peritoneal dialysis patients. As nursing care for these patients aims to reduce metabolic complications, nephrologists and nurses in peritoneal dialysis units are required to examine patients and encourage those without contraindications to get involved in safe exercises (such as pedaling on a stationary bicycle) in the peritoneal dialysis units, at home, and even at work.

Conclusion

According to the results of this study, aerobic exercise (pedaling on a stationary bicycle) can significantly decrease FBS and 2-h PPBS levels in continuous ambulatory peritoneal dialysis patients. Hence, nurses can help these patients prevent treatment complications by encouraging them to exercise. However, since small sample size in the present study limits the generalizability of the results, future studies in this field are suggested to use larger sample size and longer duration of intervention with other types of safe aerobic exercises.

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References

1. Zheng J, You LM, Lou TQ, Chen NC, Lai DY, Liang YY, *et al.* Development and psychometric evaluation of the dialysis patient – perceived exercise benefits and barriers scales. Int J Nurs Stud 2009;47:166-80.
2. Ghafourifard M, Rafieian M, Shahgholian N, Mortazavi M. Effect of linear and stepwise sodium and ultra filtration profiles on intradialytic hypotension and muscle cramps in renal disease patients. J Shahrekord Univ Med Sci 2010;12:22-8.
3. Chikotas N, Gunderman A, Oman T. Uremic syndrome and end-stage renal disease: Physical manifestations and beyond. J Am Acad Nurse Pract 2006;18:195-202.
4. Hosseinpanah F, Kasraei F, Nassiri AA, Azizi F. High prevalence of chronic kidney disease in Iran: A large population – based study. BMC Public Health 2009;9:44.
5. Zolfaghary M, Arezomanianc S, Shariat A, Sahbaey F, Mohammad Zadeh SH. Renal deiseas. In: Zolfaghary M, editor. Comperhensive Nursing. 5th ed. Tehran: Boshra; 1386. p. 345-7.
6. Thomas N. Peritoneal dialysis. Renal nursing. 8th ed. London: Balliere Tindall; 2008. p. 350.
7. Daugirdas J, Blake P, Ing T. Peritoneal dialysis. Hand book of dialysis. 4th ed. New York: Lippincott Williams and Wilkins; 2008. p. 725.
8. Heyhat A. Complication of peritoneal dialysis. Peritoneal dialysis. 1nd ed. Mashhad: Ferdoci ferdosi University Publisher; 1383. p. 26-100.
9. Norman Chan. Is Glucose a Problem in the dialysate for diabetic PD Patients? Int Soc Perit Dial 2008;13:15-9.
10. Pennell P, Rojas C, Astif A, Rossinie. Managing metabolic complication of peritoneal dialysis. Clin Nephro 2004;62:35-43.
11. Suliman M, Stenvinkel P, Qureshi AR, Kalanter –Zadenk, Barany P, Heimburger O, *et al.* The reverse epidemiology of plasma total homocysteine as a mortality risk factor is related to the impact of wasting and inflammation. Nephrol Dial Transplant 2007;22:209-17.
12. Johansen KL, Chertow GM, Ng AV, Mulligan K, Carey S, Schoenfeld PY, *et al.* Physical activity levels in patients on hemodialysis and healthy sedentary controls. Kidney Int 2000;57:2564-70.
13. Gaeini AA, Rajabi HA. Physical Fitness for special group. Phisical Fitness. 4th ed. Tehran: Samt; 1386. p. 310-75.
14. Fassett R, Robertson I, Geraghty D, Madeleine J, Burton N, Coombes J. Physical activity levels in patients with chronic kidney disease entering the LORD Trial. Med Sci Sports Exerc 2009;41:985-91.
15. Kontos PC, Miller KL, Brooks D, Jassal SV, Spanjevic L, Devins GM, *et al.* Factors influencing exercise participation by older adults requiring chronic hemodialysis: A qualitative study. Int Urol Nephrol 2007;39:1303-11.
16. Johansen K, Kaysen A, Young B, Hung A, Da Silva M, Chertow G. Longitudinal study of nutritional status, body composition, and physical function in hemodialysis patients. Am J Clin Nutr 2003;77:842-6.
17. Cheema B, Singh M. Exercise training in patients receiving maintenance hemodialysis: A systematic review of clinical trials. Am J Nephrol 2005;25:352-64.
18. Stack A, Murthy B. Exercise and limitations in physical activity levels among new dialysis patients in the United States: An epidemiologic study. Ann Epidemiol 2008;18:880-8.
19. Fallahi MJ, Shahidi SH, Farajzadegan Z. The effect of interadialytic exercise on dialysis efficacy, serum phosphate, hemodglobin and blood pressure control and comparison between two exercise programs in hemodialysis patients. J Isfahan Med Sch 2008;26:151-60.
20. Parsons TL, Toffelmire EB, King-VanVlack CE. The effect of an exercise program during hemodialysis on dialysis efficacy, blood pressure and quality of life in end-stage renal disease (ESRD) patients. Clin Nephrol 2004;61:261-74.
21. Tae DU, Sun H. Interadialytic Exercise Programs for Hemodialysis Patients. Chonnam Med J 2011;47:61-5.
22. Konstantinidou E, Koukouvou G, Kouidi E, Deligiannis A, Tourkantonis A. Exercise training in patients with end-stage renal disease on hemodialysis: Comparison of three rehabilitation programmes. J Rehabil Med 2002;34:40-5.

23. Bayliss D. Starting and managing an intradialytic exercise program. Nephrol News Issues 2006;20:47-9.
24. Mikus CR, Oberlin DJ, Libla J, Boyle LJ, Thyfault JP. Glycmic control is improved by 7 days of aerobic exercise training in patients with type 2 diabetes. J Univ Missouri 2011;32:111-7.
25. Shivananda NA, Arun MA, Manjunath HA. Influence of aerobic treadmile exercise on blood glucose homeostatsis in noninsulin dependent diabetes mellitus patients. Indian J Clin Biochem 2005;20:47-51.
26. Chi-yuen lo, Leonard Li, Wai-kei Lo, Man-lok CH. Benefitis of Exercise Training in patients on Continuous Ambulatory Peritoneal Dialysis. Am J Kidney Dis 1998;32:1011-8.
27. Painter P, Johansen KL. Improving physical functioning: Time to be a part of routine care. Am J Kidney Dis 2006;48:167-70.
28. Winter E, Jones A, Davison R, Bromly P, Mercer TH. Sport and physiology testing guidelines. The British Association of sport and exercise sciences guide. Routledge tylor and francis group. Landon and New York; 2006.
29. Raymond l. Physiological effects of exercise during dialysis on chronic renal failure patients. Dial Int 2004;2:30-5.
30. Ahmadi IR, Qajry HA. Effect Aerobic Training in hypertension and blood glucose middle age people given to hypertension and type II Diabetes. Int Conf Humanit 2011.
31. Rogers MA. Improvement in glucose tolerance after 1 week of Exercise in patients with Mild NIDDM. Diabetes Car 2003;27:613-8.
32. Barnard RJ, Lattimore L, Holly RG, Cherny S, Pritikin N. Response of Non – Insulin Dependent Diabetic Patients to an Intensive program of Diet and Exercise. Diabetes Care 1982;5:370-4.
33. Balidi JC, Snowling N. Resistance training improves glycaemic control in obese type 2 diabetic man. Int J Sports Exerc 2003;16:539-43.
34. Esfahani M. Effects of aerobic exercise on blood glucose control, cardiovascular fitness-breathing and risk factors associated with heart disease-vascular diseases in diabetic patients with mild and severe insulin independent. Olympic J 1385;36:124-9.

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