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The effects of aerobic exercise on cognitive performance and sleep quality haemodialysis patients

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RESEARCH

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ABSTRACT

Background
Cognitive impairment and sleep disturbance are very common in chronic kidney disease (CKD) and are strongly associated with increased mortality among the patients. Even though, exercise is considered to be a quantifiable activity that improves cognition in animals and humans, but few studies have examined the efficacy of exercise on cognitive function and sleep quality in CKD.

Aims
This study was performed to evaluate the effects of aerobic exercise during haemodialysis on the cognitive performance and sleep quality.

Methods
In this clinical trial study, 38 patients with an average age of 47 years under haemodialysis were divided into control (N=11) and experimental (N=27) groups. Patients in experimental group were participated in a 24 weeks training progressive exercise that performed during the first two hours of their haemodialysis on a stationary bicycle, three times a week, for 75 minutes each time. Cognitive performance using Mini-Mental State Examination, Symbol Digit Test and Trail Making Test–B and sleep quality with PSQI questioner were assessed before, 12 weeks and 24 weeks after training program. Statistical analysis was performed using SPSS 18, Mann-Whitney U and repeated measure analysis.

Results
After the exercise, there was a significant increase in the Trail Making Test–B and sleep quality during the first 12 weeks and a significant improvement after 24 weeks in Mini-Mental State Examination and Symbol Digit Test in exercise group (P<0.05).

Conclusion
It seems that aerobic exercises has a significant impact on cognitive performance and sleep quality in haemodialysis patients and can be used as part of the treatment for haemodialysis patients but further research is warranted to clarify the involved mechanisms.

Key Words
Cognitive performance, aerobic exercise, haemodialysis

What this study adds:

1. What is known about this subject?
Subjects were haemodialysis in terms of variables such as age, severity of kidney failure, duration of kidney failure, education level, location, marital status, smoking cigarette, underlying disease and cardiovascular disease.

2. What new information is offered in this study?
It determined that exercise and fixed biking had significant impact on cognitive performance in haemodialysis patients according to patient power and based on Borg measure.

3. What are the implications for research, policy, or practice?

Exercise practice lead to decrease persistent inflammatory mediator CRP. Thus exercise was effective on persistent inflammatory mediator so it improve sleep quality.

Background

Chronic Kidney Disease is a progressive and irreversible destruction in kidney function that because of its systematic effect has numerous Complications and disorders.[1] Today, 2–3 per cent of world population has suffered Chronic Kidney Disease and the number of patients doubles each seven years. The annual mortality rate is 60,000 in the world[2] and in Iran, 15 per cent is added annually to dialysis patients.[3] Patients with chronic kidney disease are confronted with mental stresses in addition to multiple physiological changes. The patients on the one hand have to tolerate stress related to extreme therapeutic action such as dialysis regarding knowledge of severity of the disease and the other hand their mental-social performance are significantly affected because of prolonged illness so that they suffered from mental disorders such as anxiety and depression and disorders in cognitive performance and sleep.[4]

Haemodialysis decreases adjustment capacity and compatibility due to the long duration and direct impact on life and followed by disorder in mental image, fear of death, limitation in diet and fluid restrictions, job loss, family problems, and impairment in quality of life, dependency to dialysis and occurrence cognitive problems and sleep disorder.[5] Cognitive disorder occurs when disorders emerge in more than one item such as memory, attention and concentration, information speed processing and verbal ability.[6] In the last stage of End-stage renal disease (ESRD), cognitive disorders are estimated 10–30 per cent among youth to middle ages. However, it is estimated 30–55 per cent in people over 50 years old.[7,8] Also there is linear relation between severity of kidney disease and cognitive disorder.[9] There is a direct relationship between cognitive disorder and occurrence clinical symptoms of dementia and increase mortality.[10,11]

Important factors related to pathophysiology of cognitive impairment among chronic kidney patients include: uremic toxins, hyperparathyroidism, micro-nutritional deficiencies, increase burden of cerebrovascular disease and disruption of the hypothalamus- pituitary- gonad axis.[12]

In the annual report of USA information system 2002 announced that sleep disorder in dialysis patients is common and it is much more compared to the general population and the figure is reported more than 80 per cent.[13] Sleep disorder exist even the initial stages of kidney disease. These disorders emerge as impairment in sleep and nightmares, insomnia and daily sleepiness.[14-16] Sleep impairment effect directly on quality of life.[17]

Control and treatment of cognitive disorder and sleep quality include pharmaceutical and non-pharmaceutical interventions. By considering problems and complication related to drug therapy, using non-drug methods that can cause increase function of chronic kidney disease patients seems reasonable. Due to high costs and complications of drug therapy non- drug methods can be used to control improvement of cognitive performance of patients.[18] Until now, different non- drug methods were studied as a complementary medicine for decreasing anxiety and depression in patients and different conditions. These methods include massage therapy, sports exercises, acupuncture and acupressure, music therapy, prayer and religions practices.[19] and some of the methods while usefulness, have special limitations. Physical exercises are the most important alternative treatment at improvement of cognition and sleep.

According high prevalence of cognitive impairments and sleep disorder in haemodialysis patients, availability and easiness, no need to special equipment, low cost and not having an important complication of exercise, present study is done for effectiveness of dynamic exercises on cognitive performance and sleep quality of haemodialysis patients in Arak.

Method

In this clinical practice study, 38 subjects were selected voluntarily in 2015-2016 among haemodialysis patients were filed in the Association for Protection of Kidney Patients and private centres in Arak that have criteria for entering the study. Selected patients were randomly assigned in two groups: experimental (N=27) and control group (N=11). Sample size was determined based on research principles in psychology sciences.[20]

All intervention process was done individually at dialysis centre after acquiring the code of ethic (No: 93-168-1). Control and treatment groups were informed morally the result of study after end of research. Entrance criteria to study include: confirmation of diagnosis by a specialist, lack of other chronic diseases, such as: orthopaedic, rheumatologic and neurological, ability to communicate and cooperate, 16–60 years old, reading and writing literacy,

tending to participate in research and at least one year history of dialysis treatment among important exclusion measures, it can be referred to occurrence orthopaedic problems, MI in last month, lack of ability to complete 70 per cent of exercise program, heart disease, uncontrolled diabetes, psychological or severe cognitive disorder and lack of ability to do exercise such as Parkinson, ALS, myopathy and neuropathy.

Firstly, two groups were homogenized regarding different variables such as age, severity of kidney disease, duration of kidney disease, education level, location, marital status, smoking cigarette, underlying disease and cardiovascular diseases. All of patients were studied based on trial making test B (TMT – B – EXAM). This test is used for assessment of mild cognitive disease. Reliability coefficient and validity are respectively 89 per cent and 62 per cent.[21] Symbol Digit Test as a simple and fast test is used for studying cognitive status. This test also had acceptable reliability and validity according to age and sex[22] Mini- Mental State Examination (MMSE) was used as a tool for studying total cognitive disorder. This test had proper validity and reliability in numerous researches[23,24] and it had differentiability of subjects with cognitive impairment with cut-off point 22. Cronbach's alpha coefficient was obtained for determining internal reliability. It was 0.81. Score 22 was considered as a cut-off point using ROC curve. The amount of sensitivity and specificity of this test are 90 per cent and 93.5 per cent respectively. Pittsburgh Questionnaire (PSQI) was studied for evaluating sleep quality. Exercise program were done three times a week simultaneously with haemodialysis sessions for 75 minutes at the first two hours of dialysis and for six months. This program included practice with fixed bike Technogym, Reclie exite 700i D4D UR Ver SW 55. 25.0model. Every practice session was divided into five sections. First part includes warm up for five minutes with eight to nine severity according to Borge Measure. At the second stage, exercises were followed with 12–14 severity according to Borg Measure for 30 minutes. In the third step, exercise was stopped and patient rest for 15 minutes. At the next stage, exercise was done for 30 minutes with 12–14 severity and at the final stage patients had cool down movement with eight to nine severity. After three months and creating neural, muscular, cardiovascular adaptation, severity of exercise as increased to 15 according to Borge measure.[25,26]

Fixed bike was easily portable and it placed next to the patients' bed. Also heart rate and blood pressure were measured at rest, in the 15th and 30th minutes of exercise and in the 30th minute of reconstruction. All patients performed exercise test before and at the end of study to determine maximum heart rate and capacity function.
Finally after three and six months since beginning of study, necessary consideration was done again with the same tools and same initial style. Date was analysed statistically by SPSS 18 software by charts and table and also using chi-square test or repeated measure test Table 1.

Results

In the present study, 38 subjects who treated with Haemodialysis with age average 47 including 23 male (60.5 per cent) and 15 female (39.5 per cent) participated. They had at least 1.5 years and maximum 12 years had history of haemodialysis. 52.6 per cent and 49.8 per cent of treatment and control group had not history of exercise and physical activity during treatment years with dialysis ($p \geq 0.05$).

Repeats measured test show that Mini- Mental state Examination (MMSE) and symbol Digit Test had not statistically significant difference after doing aerobic exercise ($p \geq 0.05$). But after 6 month following exercise, they had found statistically significant increase in treatment group ($p \leq 0.05$) and section B of TMT-B-EXAM (Trail making Test-B) and sleep quality index in the first three month had significant increase and the difference was increased in next six months ($p \leq 0.05$). Both groups had not significant different on physical activity, exercise and taking sleep medication before beginning treatment based on chi-square test ($p \geq 0.05$) Table 2.

Comparison of results in different times based on Independent T-test in below curve shows variation level in cognitive performance and sleep quality of patients in both groups (Figures 1-4).

Figure 1: Comparison scores of Mini-Mental State Examination in both group based on time

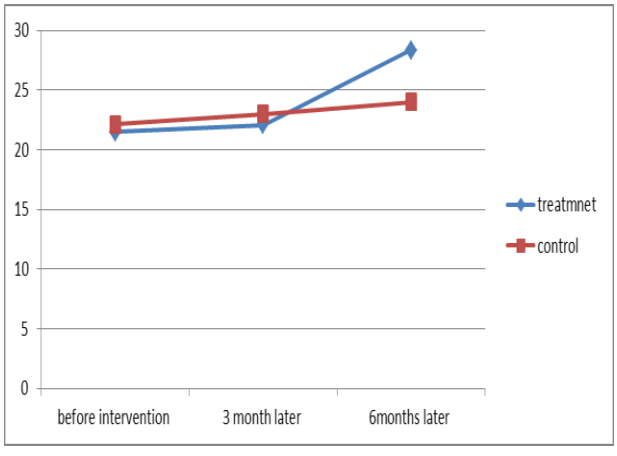


Figure 2: Comparison scores of Symbol Digit Test in both group based on time

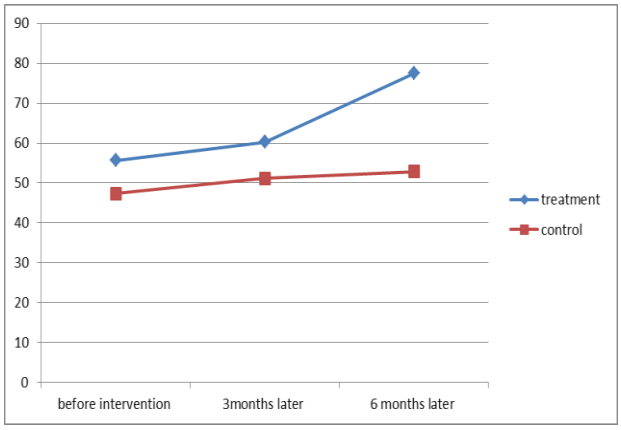


Figure 3: Comparison scores of Trail Making Test-B in both group based on time

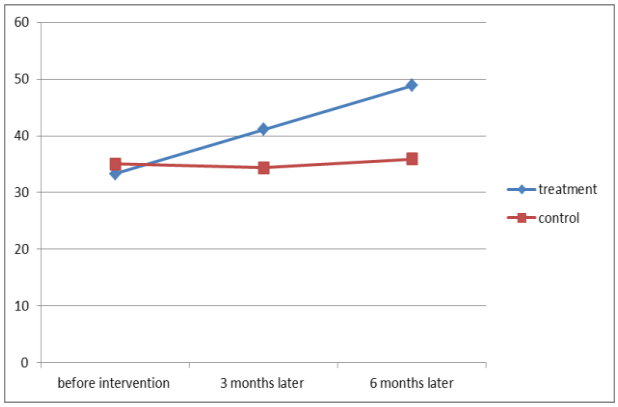
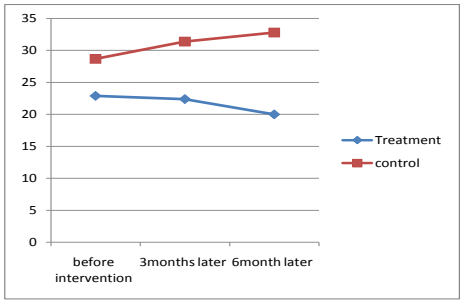


Figure 4: Comparison scores of Pittsburgh Test in both group based on time



Discussion

This study had done to determine effectiveness of aerobic exercise on cognitive performance and sleep quality in haemodialysis patients of Arak city. Findings show that both groups were haemodialysis in terms of variables such as age, severity of kidney failure, duration of kidney failure, education level, location, marital status, smoking cigarette, underlying disease and cardiovascular disease. Therefore, it cannot judge about probable effect of variables on expected implications of research due to consistency. Also it determined that exercise and fixed biking had significant impact on cognitive performance in haemodialysis patients according to patient power and based on Borg measure. The overall cognitive function of the patient improved after six months but cognitive performance function and violation of cognitive mild had improved since first three months based on section B of TMT-B- EXAM (Trail Making Test- B). Sleep quality also improved after three months and it was better in the next six months. Colcomb et al.[27], studied 59 haemodialysis under aerobic exercise treatment and finally some variation were observed in oxygen absorption and brain volume in different locations such as cortex, cingulated, motor area, middle frontal, superior temporal lobe in MRI. These locations were involved at the beginning of cognitive impairment. In Martin and et al.[28], same conclusion as obtained based on MMSE Test. Findings of research done by Hillman et al.[29] as "effect of exercise on brain and cognition" show that aerobic exercise has effect on some of brain performance dimensions, educational performance on cell level, systemic molecular and behavioural. Leehey et al.[30] in a clinical trial" effect of aerobic exercise on diabetic obese patient with chronic kidney disease" showed that aerobic exercise lead to improvement cognitive status. Sakkas et al.[31] show in the clinical trial effect of aerobic exercise on restless legs symptoms and improvement of cognitive performance at haemodialysis" show that 16 weeks aerobic exercise lead to decrease of restless legs symptoms and improvement of life quality in dialysis patients while these methods were safe and harmless.

Researcher in spite of extensive search on scientific search engines, could not find a research that show negative effect of exercise on cognitive performance even in other diseases. So there was not possibility for presenting mutual hypothesis.

Some of studies[32,33] suggested that cardio vascular status and hemodynamic changes in kidney patients and the major effect of hypotension on brain ischemic cause pathology of cognitive impairment in patients. Anaemia is presented as another effective factor.[34] Weiner et al. presented numerous factors such as vascular disorders and Alzheimer, metabolic status and Aluminium toxicity on incidence of cognitive disorder in these patients.[35]

Among designable assumption for improvement cognition status of haemodialysis due to exercise, it can be referred to brain atrophy prevention[36] changing brain neurotransmitter and Neurotropics[37] angiogenesis and synaptogenesis[38] neurogenesis[39] reducing stress[40] and increasing brain derived neurotrophoic factor[41] which doubtless lead to better efficiency over time that is why the status of patient was better after six months compared to these after three months.

Shavand et al.[42] find that resistance training during 8 weeks while dialysis lead to improve sleep quality and muscular readiness in haemodialysis patients and this was accompanied with reduction of reactive protein C levels. Research by Afshari et al.[43] shows that aerobic exercise during 8 weeks by assuming increase blood circulation skeletal muscle, change in electrolyte and water shift and inflammatory factor CRP and on Pittsburgh sleep quality index was effective.

Multiple conditions might lead to sleep disorder among patients such as bad metabolic conditions, pain, food limitations, fatigue, muscle cramp and mental problems.[44] But recently there is strong hypothesis which claims sleep disorders in patient related to chronic inflammatory condition.[17] New studies about haemodialysis show that insomnia is related to increased proinflammatory factors (IL- 18, TNF-α, IL-6, IL-1).[17,28,45] Increasing plasma levels of cytokines lead to increase hypothalamus- pituitary- adrenal axis and increase body temperature and decrease Non-rapid eye movement (NREM). New studies show that exercise practice lead to decrease persistent inflammatory mediator CRP. Thus exercise was effective on persistent inflammatory mediator so it improve sleep quality.[46,47]

On the other hand, rapid variations in serum electrolytes and balance of acid base and omission some of effective substances secreted by the endocrine on sleep are common causes of night-time sleep disorder, fatigue and sleepiness during day and it seems that movement, massage and exercise can lead to improvement of sleep quality in patients.[48-50] Significant improvement of sleep quality after 6 months treatment was similar in Asadnia et al.[50] study, because sleep quality is evaluated by subscales of sleep quality, delay to fall sleep, sleep disorder and taking sleep medications and improvement of these factor required passing time.

Conclusion

Considering high prevalence of cognitive disorders among haemodialysis patients and the finding of present study that confirmed effectiveness of aerobic exercise on improvement of cognitive performance, it suggest that by including different techniques of aerobic exercise to improvement and even prevention cognitive disorders in chronic diseases specially patient treated with haemodialysis.

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PEER REVIEW

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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Table 1: Frequency distribution of exercise status in two groups based on the number, per cent and results of Chi-square Test

		Treatment group	Control Group	**Sum**	p-v *
Exercise	+	12(45.5%)	5(44.4%)	17(44.7%)	0.8
	-	15(55.6%)	6(54.4%)	21(55.3%)	
	total	27(100%)	11(100%)	38(100%)	
ESRD	Diabetes	6(23.1%)	5(45.5%)	11(29.7%)	0.4
	blood pressure	1(38.5%)	3(27.3%)	13(35.1%)	
	Polycystic	2(7.7%)	1(9.1%)	3(8.1%)	
	Glomerulonephritis	5(19.2%)	0(0.0%)	5(13.5%)	
	other	3(11.5%)	2(18.2 %)	5(13.5%)	
	total	26(100%)	11(100%)	37(100%)	

* chi-square test

Table 2: Comparison cognitive status and sleep quality in treatment and control based on time

Variable	**Group**	**Pretest (standard deviation mean)**	**3 months later (standard deviation mean)**	**6 months later (standard deviation mean)**	**Changes percent**	**P-v***
Mini-Mental State Examination	Treatment	21.46±21.15	22.06±1.8	28.32±3.03	24%	0.001
	Control	22.1±2.08	23.01±1.95	24.01±2.5	7.90%	0.683
	P-v**	0.1	0.2	0.8		
Symbol Digest Test	Treatment	55.61±23.5	60.21±11.9	77.46±20.5	28.20%	0.003
	Control	47.3±17.5	51.11±20.9	52.81±12.7	10.40%	0.239
	P-v**	0.1	0.04	0.04		
Trail Making Test-B	Treatment	33.31±10.4	41.11±10.9	48.81±10.1	31.17%	0.001
	Control	35±7.5	34.38±7.6	38.93±12.2	2.60%	0.348
	P-v**	0.7	0.6	0.5		
Sleep Quality	Treatment	22.9±7.7	22.4±9.4	20±9.1	-14.50%	0.001
	Control	28.7±8.7	31.4±10	32.8±7.7	12.50%	0.348
	P-v**	0.1	0.02	0.001		

** Mann-Whitney U

* Repeated Measures analyses