Middle-East Journal of Scientific Research 22 (4): 494-498, 2014
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2014.22.04.86264

Effect of Physical Training on the Immune System and Stress Hormones in Diabetics

[1]Aisha A. Hagag and [2]Mahmoud A Saudi

[1]Department of Physical Therapy for Cardiovascular/Respiratory Disorders and Geriatrics, Faculty of Physical Therapy, Cairo University, Giza, Egypt
[2]Clinical Pathology Department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

Abstract: This study was conducted to investigate the effect of physical training on the immune system and stress hormones in diabetic patients. Sixty male and female patients with controlled type 2 diabetes were recruited from out patient's clinic of Elkasr-Elini teaching hospital, their ages ranged from 40-65 years old. They were randomly divided into exercise (n=30) and control (n=30) groups. Procedure aerobic exercise training program was performed on a treadmill at intensity 60-70-% of the maximum heart rate, three times weekly for twelve weeks. Fasting blood samples were taken in the first day of the study and at the second day after the end the study, for determination of immunological parameters and stress hormones. Student's t test for independent samples was used for the statistical analysis, considering $p< 0.05$ as the statistical significance level. Results revealed significant increase in the humoral immune parameters including IgA, IgG and IgM in the exercise group. While there were significant decreases in stress hormones including ACTH and cortisol. In conclusion regular and moderate exercises have favorable effects on the immune system by increasing immunoglobulins which are potent protective; also can decreases stress hormones in diabetics which may be helpful in cutting stress for these patients.

Key words: Physical Training · Immune System · Cortisol · Diabetes Mellitus

INTRODUCTION

diabetes mellitus is a complex metabolic disorder characterized by persistent hyperglycemia resulting from deficits in insulin secretion that lead to disorder of carbohydrates, fat and protein metabolism, it affects 15% of world population over the age of 65 years in developed countries. The rate of incidence of diabetes reaches a percentage of 20-50% throughout different age group [1].

The chronic insulinopenia and hyperglycemia on diabetes is associated with damage of various organs. Regular exercises improve metabolic control in diabetic individual and is an important component in treatment of diabetes mellitus, exercise increases cardiovascular fitness, glycemic control, decreases insulin resistance, improve lipid profile, attenuate weight loss and enhance immune response [2].

The course of the infections in diabetes is more complicated in this patient group due to decrease in immunity [1].

Regular exercise has been reported to have several favorable effects on physiological, psychological and immunological functions [3].Vigorous exercise, however, has been reported to have a negative effect on these functions [4].

Regular and moderate amounts of exercise appear to enhance immunity and reduce the number of infectious episodes that an individual suffers. The incidence of upper respiratory tract infection was studied in two groups of sedentary obese women and was found to be significantly lower in the group who took up regular exercise than in the group that remained [5].

Stress causes higher blood sugar levels in people with either type of diabetes. And blocks the body from releasing insulin in people with Type 2 diabetes, so cutting stress may be more helpful for these people [6].

There is substantial evidence indicating that physical activity has beneficial effects on physical and mental health and that it is protective against the detrimental consequences of chronic stress and stress-related diseases [7].

Corresponding Author: Aisha Abdelmonem Hagag, Department of Physical Therapy for Cardiovascular/Respiratory Disorders and Geriatrics, Faculty of Physical Therapy, Cairo University, Egypt.

Sugiura *et al*. [8] studied the effect of chronic exercise training on immune system in exercising rats. The protocol was three days /week for eight weeks. After exercise program the rats showed improvement in macrophages and lymphocyte functions.

Despite the numerous studies aimed at explaining the specific immune response to exercise, most of them focused on the changes following exercise of short duration, others examine the effect of exercises on immune system and stress hormones in healthy subjects [9]. There have been a limited number of studies examining the effects of regular exercise in the long term on the immune system in diabetic patients [10].

Aim of Study: This study was conducted to investigate the effect of physical training on the immune system and stress hormones in diabetic patients by measuring the humoral immune parameters, serum adrenocorticotrophic hormone (ACTH) and cortisol levels.

Methodology

Subjects: Sixty male and female patients with controlled type2 diabetes were recruited from out patient's clinic of Elkasr-Elini teaching hospital, their ages ranged from 40-65 years old. They were randomly divided into exercise (n=30) and control (n=30) groups. The study had local research and ethics committee approval and all subjects gave written consent.

Exclusion Criteria: Patients with history or finding of cardiovascular, endocrinal or immunological disorders were excluded. Any neurological or orthopedic disorders were also excluded. All patients were able to walk independently without pain or a walking aid.

All patients underwent anthropometrical measurements, Systolic blood pressure (SBP), diastolic blood pressure (DBP) and resting heart rate (HR) before the beginning of the study.

Cardiopulmonary Exercise Test Procedure: Before conducting the exercise tolerance test, subjects of the exercise group had to visit the laboratory to be familiarized with the equipment in order to be cooperative during conducting the test. Each subject underwent continuous progressive exercise tolerance test according to modified Bruce protocol which consists of warming up phase and five active phases and recovery phase in order to determine the maximum oxygen consumption (VO2max)[11].

The Aerobic Exercise Training Program: The aerobic treadmill-based training program was started with a 5-minute warm-up phase performed on the treadmill at a low load, Active phase of the training session was gradually increased from 20 to 40 minutes in the form of walking/running on electronic treadmill with zero inclination three times per week for twelve weeks, its intensity from 60% to 70% of the maximum heart rate (HRmax) achieved in a reference exercise testing performed according to modified Bruce protocol. This rate was defined as the training heart rate (THR) and ended with 5-minute recovery and relaxation phase.

Blood Sampling: Fasting blood samples from the ante-cubitalvein were taken from subjects in the both groups at 8.30 AM of the first day of study period and at 8.30 AM on second day after the end of the study period. Subjects were instructed not to exercise within 12 hours before blood sampling, the blood samples were transported to the laboratory and sera separated as soon as possible and stored at –80°C until analyzed. IgA, IgG, IgM determinations were done nephelometry using the Space model (Nephstar Protein Analysis System (. ACTH and cortisol determination was done using the Cobas e411 (Roche Hitachi) model hormone analyzer employing the chemiluminesence method.

Statistical Analysis: The mean values of data obtained for both groups before and after the study periods were compared using paired "t" test. Independent "t" test was used for the comparison between the two groups ($p<0.05$).

RESULTS AND DISCUSSION

Different results have been obtained in studies concerning the effects of exercise on the immune system [12]. In addition to factors like type, duration and intensity of the program of exercise, various complex mechanisms including hormonal, metabolic and psychoneural stress are also known to have effects on the immune system [13].

The results of the present study showed significant increase in humoral immune parameters including IgA, IgG and IgM in the exercise group. While there were significant decreases in stress hormones including ACTH and cortisol. These elevated levels of immunoglobulines may be attributed to the chronic effect of regular exercises [14].

Table 1: general characteristics of exercise and control groups

Variable	Exercise group n=30	Control group n=30	P	Significance
Age(yr)	50.63±0.59	52.51±0.64	0.170	NS
Weight(Kg)	70.00±1.41	73.06±1.87	0.101	NS
Height(Cm)	160.53±3.18	159.62±4.05	0.212	NS
Resting heart rate	66.5±3.2	65±1.8	0.321	NS
Bp-systolic	130±1.5	132±1.8	0.112	NS
BP-diastolic	73±1.8	72±2.2	0.101	NS

Table 2: Comparison of the Immunoglobulin and hormonal Parameters in both groups

Variable	Exercise group(n=30)	Control group(n=30)	#p
IgA(g/Lt)			
Pre	1.87±0.16	1.76±0.13	Ns
Post	2.19±0.22**	1.79±0.16	P <0.05
IgG(g/Lt)			
Pre	12.43±0.31	13.11±0.12	Ns
Post	15.65±0.11**	12.88±0.32	P <0.05
IgM(g/Lt)			
Pre	1.03±0.05	1.05±0.07	Ns
Post	2.01±0.07**	1.06±0.08	P <0.05
ACTH			
Pre	36.12±1.02	34.11±1.22	Ns
Post	32.23±2.05**	35.07±1.32	P <0.05
Cortisol			
Pre	12.34±1.45	10.03±1.22	Ns
Post	9.25±1.09**	9.23±1.13	P <0.05

**p□ 0.05 within group between pre- and post-training (paired t -test); #p value between exercise and control group.

Nehlsen *et al*. [15] reported that at 60% of max VO2 moderate exercise results in transient increases in the IgG, IgA and IgM levels. In the same study, it was found that at the 6th week of the training exercise program with intensity of 60% max VO2, similar increase in the basal immunoglobulin levels was noted. In a different study, it has been reported that the plasma immunoglobulin levels was increased by regular exercise of moderate intensity [16]. The present study revealed an increase of IgA, IgG and IgM levels by regular exercise are in agreement with Pyne *et al*. [17-19].

Previous studies mentioned that exercise-trained individuals show a reduction in pituitary–adrenocortical activation and a lower degree of sympathetic system activation in response to a given absolute workload of physical stress compared to untrained men [20].

Authors revealed that exercise increases the production and catabolism of cortisol. The level rises transiently during exercise of both moderate and severe intensity and falls rapidly to the basal level or below within a few hours of completion of the exercise. There is a rise of similar proportions in both fit and unfit individuals when exercising to exhaustion. For a given amount of exercise, there is a greater rise in the unfit. The magnitude of the rise in cortisol declines as training continues and subjects improve their fitness [21].

Yazdanparast *et al*. [22] assessed the effect of low, moderate and high intensity exercises on cortisol concentration. Highest concentration of cortisol was showed in high intensity exercises and the lowest concentration of cortisol was in the moderate intensity exercises.

Hormonal responses induced by different strength training intensities were compared in research conducted by Hamid *et al*. [23]. Their results showed reduced cortisol levels for the group that performed exercises at 50% 1RM and increased levels in the group that exercised at 80% 1RM.

However, Vale *et al*. [24] investigated the effect of 12 weeks of different exercise protocols on the cortisol levels of elderly subjects. The sample was divided into a strength training group, aerobic training group and a control group. After the intervention there were no significant alterations in intra and intergroup cortisol concentrations.

CONCLUSION

Whereas aerobic exercises led to elevated levels of serum immunoglobulin and decreased level of cortisol and ACTH. According to the data obtained from this study,

we concluded that regular and moderate exercises have favorable effects on the immune system by increasing immunoglobulins which are potent protective; also can decreases stress hormones in diabetics which may be helpful in cutting stress for these patients.

ACKNOWLEDGMENTS

We thank all the participants for taking part in this study.

REFERENCES

1. Expert Committee on the diagnosis and classification of diabetes. Report of the expert committee on diagnosis and classification of diabetes, 2003. Diabetes care, 26: S5-20.
2. Potiier, P., A. Saski and C. Frank, 2005. New aspects of diabetes. Ann Pharm Fr, 36: 371-84.
3. Mackinnon, L.T., 2000. Chronic exercise training effects on immune function. Med Sci Sports Exerc, 32: 369-S376.
4. Moldoveanu, A.I., R.J. Shephard and P.N. Shek, 2001. The cytokine response to physical activity and training. Sports Med Review, 31: 115-144.
5. Mackinnon, L.T., 2000. Effects of exercise on the immune system: overtraining effects on immunity and performance in athletes. Immunol. Cell Biol., 78: 502-509.
6. Huang, C.Y., V.D. Sousa, H.F. Chen, S.Y. Tu, C.J. Chang and I.J. Pan, 2007. "Stressors, depressive symptoms and learned resourcefulness among Taiwanese adults with diabetes mellitus." Research and Theory for Nursing Practice, 21(2): 83-97.
7. Nabkasorn, C., N. Miyai, A. Sootmongkol, S. Junprasert, H. Yamamoto, M. Arita and K. Miyashita, 2006. Effects of physicalexercise on depression, neuroendocrine stress hormones andphysiological fitness in adolescent females with depressivesymptoms. Eur. J. Public Health, 16: 179-184.
8. Sugiura, H., H. Nishida, R. Inaba and H. Iwata, 2000. Immunomodulation by eight weeks voluntary exercises in mice. Acta Physiol. Scand, 168: 431-20.
9. Rowbottom, D.G. and K.J. Green, 2001. Acute exercise effects on the immunesystem. Med. Sci. Sports Exerc., 32: 396-405.
10. Zinman, B., N. Ruderman, J.T. Delivin and S.H. Schneider, 2004. Physical activity/ Exercise and diabetes. Diabetes care, 27: S58-62.
11. Vanessa, N. and D. Elizabeth, 2000. Submaximal exercise testing: clinical application and interpretation. Physical therapy, 80: 782-807.
12. Pyne, D.B., M. Gleeson, W.A. Mcdonald, R.L. Clancy, C.J. Perry and P.A. Fricker, 2000. Training strategies to maintain immunocompetence in athletes. Int. J. Sports Med., 21: 51-60.
13. Filaire, E., J. Bonis and G. Lac, 2004. Relationships between physiologicaland psychological stress and salivary immunoglobulin A amongyoung female gymnasts. Percept Mot Skills, 99: 605-617.
14. Nash, M.S., 1994. Exercise and immunology. Med Sci. Sports Exerc, 26: 125-127.
15. Nehlsen-Canarella, S.L., D.C. Nieman, J. Jensen and G. Chang, 1991. The effect of moderate exercise on lymphocyte function and serum immunoglobin. Int J. Sports Med., 12: 391-398.
16. Bauer, T. and B. Weisser, 2002. Effect of aerobic endurance exercise on immune function in elderly athletes. SchweizRundsch Med. Prax, 30(91): 153-158.
17. Pyne, D.B., M. Gleeson, W.A. Mcdonald, R.L. Clancy, C.J. Perry and P.A. Fricker, 2000. Training strategies to maintain immunocompetence in athletes. Int J. Sports Med., 21: 51-60.
18. Nieman, D.C. and S.L. Nehlsen Cannarella, 1991. The effect of acute and chronic exercise on immunoglobulin. Sport. Med, 11: 183-201.
19. Daniel, M., A. Jose and A. Marie, 2010. Effect of physical training on the immune system in diabetic rats. In. J. DiabDevCtries, 30(1): 33-36.
20. Ulrike, R., C.Z. Bea, M. Bernard and H. Markus, 2007. Trained men show lower cortisol, heart rate and psychological responsesto psychological stress compared with untrained men. Psychoneuroendocrinology, 23: 627-635.
21. Nabkasorn, C., N. Miyai, A. Sootmongkol, S. Junprasert, H. Yamamoto, M. Arita and K. Miyashita, 2006. Effects of physical exercise on depression, neuroendocrine stress hormones and physiological fitness in adolescent females with depressive symptoms. Eur. J. Public Health, 16: 179-184.
22. Yazdanparast, B., M. Azarbayjani, M. Rasaee and S.M. Ostojic, 2009. The effect of different intensity of exercises on salivery steroids concentration in elite female swimmers. Phys. Edu.Sport, 7: 69-77.

23. Hamid, M., A. Mohammad and M. Hiwa, 2012. Effect of 8 Weeks Low and High Intensity Resistance Training on Leukocyte Count, IgG, Cortisol and Lactate Concentration in Untrained Men,World Applied Sciences Journal, 16(7): 949-954.

24. Vale, R., R. de Oliveira, C. Pernambuco, Y. Meneses, J. Novaes and A. Andrade, 2009. Effects ofmuscle strength and aerobic training on basal serum levels of IGF-1 and cortisol inelderly women. Arch. Gerontol. Geriatr., 49(3): 343-7.