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# Assessment of Maximal Oxygen Consumption and Resting Heart Rate among Type 2 *Diabetes Mellitus* Males during a 12 Week Exercise Program

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*Abstract*. The objective of the present study is to investigate the effects of aerobic training on maximal oxygen consumption, resting heart rate, body mass index and body weight in males with conducted on type 2 *diabetes mellitus*. Twelve week closely supervised aerobic training program was twelve inactive men with type 2 *diabetes mellitus* (age 25-55 yrs.). Two patients discontinued training for different reasons. Intensity of training was from 40-60% of maximum heart rate, duration 30-40 minutes and frequency 3 times a week. Results showed significant difference in pre and post means of maximal oxygen consumption and resting heart rate. Mean maximal oxygen consumption improved from 59.66 ± 4.73 to 68.88 ± 4.73 ml/kg/min [t (9) = -3.03, P < 0.016]. Improvement were also seen in mean resting heart rate from 82.28 ± 9.14 to 74.42 ± 6.82 beats/minute [t (9) = 2.89, P < 0.027]. No significant improvement was seen in body mass index [t (9) = 1.17, p > 0.285] and body weight [t (9) = 1.09, p > 0.317]. Twelve week aerobic training was effective in improving maximal oxygen consumption and resting heart rate in male diabetic patients. However, training was not effective enough to reduce body weight and body mass index in diabetic patients.

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## Introduction

Physical activity in some form or another is important for diabetic people. Not only physical activity helps and support diabetic people to lead normal life, at the same time it also improves the cardiovascular health of a person[1].

The socioeconomic consequences of diabetes and its complications could seriously have a negative impact on the economies of the developed and developing nations[2].

Type 2 *diabetes mellitus* (T2DM) is the sixth-leading cause of death[3] in USA, most of those deaths were attributed to cardiovascular disease (nearly 70%) and ischemic heart disease (nearly 50%) that are responsible for the high mortality rate[4].

Maximal oxygen consumption ($VO_{2max}$) is one of the major predictors of cardiovascular well being. It is also termed as aerobic capacity. $VO_{2max}$ helps to assess the cardiac health of an individual. Aerobic capacity of a person can be tested and measured through various direct and indirect methods as described in the literature.

Regular physical activity also has the potential to improve the status of several cardiovascular risk factors such as body composition, blood pressure, blood lipids, cardiorespiratory fitness and fibrinolytic functioning, as well as the quality of life and perceived well-being[5].

Up to 80% of people with type 2 diabetes do not perform enough physical activity to improve their health. Moreover, in comparison to the general population, people with diabetes experience a higher frequency of relapse due to their sedentary behavior[6]. Promotion of the importance of physical activities in current diabetes care is inadequate. People with type 2 diabetes report receiving not enough support, lower education and less encouragement to undertake physical activities than reported for any other area of diabetes management[7].

## Methods

This prospective interventional study was conducted on type 2 diabetic male patients from the diabetic clinics at King Fahd Hospital of the University (KFHU), Khobar, KSA, with an age range between 25-55 years, and following a supervised training program in the sport centre at King Fahd University of Petroleum and Minerals (KFUPM), Dhahran, KSA, from July to October 2012.

Exclusion criteria included subjects living very far from the training center; risk of cardiovascular disease, documented retinopathy; neuropathy; asthmatics; arthritis and morbid obesity, in addition to those involved in any physical exercise regimen.

All participants signed a written consent form after being informed about all the risks associated with exercise training program. Comprehensive medical screening and fitness assessment was performed for each subject before and after participation in exercise training program. All subjects continued their usual medical care. Diet and life style of patients were not controlled in the study and were advised to follow their normal routine.

### *Intervention*

Exercise training program was offered at the fitness center of KFUPM and all twelve subjects were provided membership. Entire duration of 12 week exercise training program was closely supervised by two qualified trainers. Attendance was verified every day through direct observation and daily record keeping. Exercise data was also recorded every day on a chart. To test for blood glucose levels, motoring was performed before and after exercise training program. Aerobic exercise was performed at treadmills and bicycles. The aerobic exercise training program consisted of walking or jogging on a treadmill and cycling on cycle ergometer. Each training session consisted of 10 minutes of warm up followed by 10 minutes of cooling down period. Subjects performed exercise three times a week on alternate days. The training was designed to provide an alternate day as a replacement for missed training session during the week. Subjects started with training intensity of 40-50% of their maximum

heart rate (MHR), and thereafter, intensity and duration was increased every 4 weeks as summarized in Table 1.

**Table 1. Intensity and duration of aerobic exercise training program.**

| Week | Intensity | Duration |
|---|---|---|
| 1 - 4 | 40 – 50% of MHR | 30 min on Treadmill & 20 min on Cycle Ergometer |
| 4 - 8 | 50 – 60% of MHR | 35 min on Treadmill & 20 min on Cycle Ergometer |
| 8 - 12 | 60 – 70% of MHR | 40 min on Treadmill & 20 min on Cycle Ergometer |

*Familiarization*

Before beginning the exercise training program, all subjects went through a two-week familiarization program. Subjects performed aerobic exercise on a treadmill and cycle ergometer for 15-20 minutes for two weeks at 30-40% of MHR. Thereafter, all subjects underwent baseline measurement for selected variables. All the measurements were after twelve weeks of training program to see whether there was a significant difference before and after training.

*Testing Procedures*

Anthropometric Measurement: Body mass and vertical height were measured before the beginning of exercise training program and body mass index (BMI) was calculated. $VO_{2max}$ was measured prior to exercise training program by single stage treadmill walking test[8].

Resting heart rate (RHR) was measured at radial artery. Subjects were asked to sit for at least 30 min in relaxed position before taking measurements and were advised not to do any moderate or vigorous physical activity for at least 2-3 hrs before the test.

Maximum heart rate was calculated by using formula:

220 – Age [9].

The blood glucose level before and after each exercise session was measured each patient. For this reason, each participant was given Accu-Check Glucometer along with strips, lancet and alcohol swab to measure their glucose levels before and after the exercise session.

*Statistical Analysis*

The statistical analysis was performed using IBM Statistical Package for the Social Sciences, version 20.0 (IBM Inc., Armonk, New York USA). Normality of distribution was assessed by the Kolmogorov Smirnov test. Since our data was normal, an employed paired *t* test was used to see the changes after 12 weeks of aerobic training. Statistical significance was considered for p values $< 0.05$. Data were shown as mean and standard deviation.

## Results

Twelve male sedentary patients diagnosed with T2DM were enrolled in this study. Their ages were ranged from 25-55 years (average age: 43.86 ± 10.3 years).

Only ten subjects completed 12 weeks of exercise training program. However, the training program was well tolerated by all the participants, those who left the program did so because of personal reasons. The hundred percent adherence to the training session were established at 36 training sessions, which was three times per week for a total period of 12 weeks.10 people attended the whole program with rough adherence rate per session of (83.79%) , we had only two patients left the training program after 4 weeks; one of them withdrew because he had to attend an in service training course in his office and other one discontinued because of family problems. No adverse complications occurred during the training program except for some temporary muscle soreness. No injuries and/or cardiovascular complications occurred during the training program.

Analysis of results revealed that there was a significant difference in baseline and post exercise training means of $VO_{2max}$ and resting heart rate. Mean $VO_{2max}$ showed significant improvement from 59.66 ± 4.73 to 68.88 ± 4.73 mL/kg/min [$t(9) = -3.03$, $p < 0.016$]. A significant improvement was also seen in mean resting heart rate from 82.28 ± 9.14 to 74.42 ± 6.82 beats/minute [$t(9) = 2.89$, $p < 0.027$]. However, our study could not find any significant improvement in mean BMI [$t(9) = 1.17$, $p > 0.285$] and mean body weight [$t(9) =$

1.09, $p > 0.317$] after 12 weeks of aerobic training program. All these findings are shown in Fig. 1.

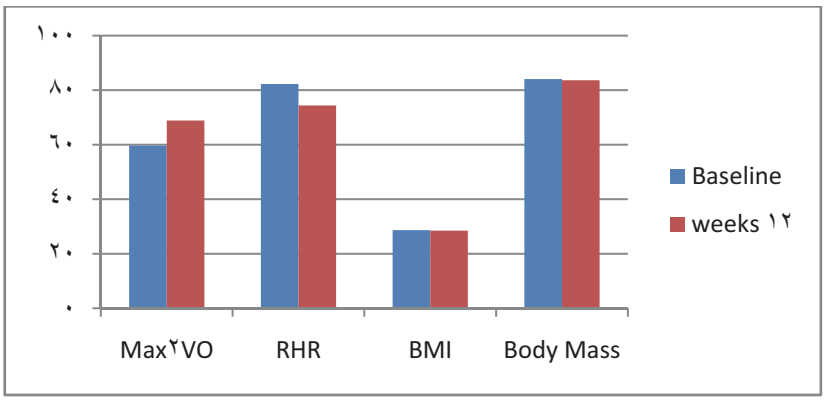


**Fig. 1. Reported Means of $VO_{2max}$, Resting Heart Rate (RHR), BMI and Body Mass**

The effect of this training program on the glycemic control of these patients was published in another journal [10].

## Discussion

Twelve weeks of aerobic exercise training program has improved significantly $VO_{2max}$ and resting heart rate in subjects with T2DM. The results from our study are supported by previous studies[11-14]. Aerobic exercise program had improved the $VO_{2max}$ along with reduction or improvement in body weight/BMI/body in subjects with T2DM[11-14], on contrary to that; our study found significant difference in $VO_{2max}$ and showed no significant changes in body weight and BMI in T2DM subjects. According to Wing *et al.*[15] and Brun *et al.*[16] there was no change seen in body weight or BMI after aerobic exercise training. Results of our study are consistent with what was published by other investigators[17]; where they found increase in $VO_{2max}$ with no change in body composition. Most probable reason for no change in body weight and BMI could because no advise was given to subjects for diet control during the whole training program, which could have affected the BMI and body weight in some or other way. Moreover, this study's training program

did not focus on weight loss in subjects. Hence, the training program was prepared primarily to see improvement in $Hb_{A1c}$ in T2DM subjects. These results are part of larger study where the effect of aerobic training on $Hb_{A1c}$ improvement in T2DM subjects was actually seen.

The limitations of this study include the small size of our population who represented only males and, lack of control group and the short duration of the training program. They are representative data could be obtained in case the study was extended from 6–12 months.

## Conclusions

Twelve weeks aerobic exercise training program was significantly effective in improving $VO_{2max}$ and resting heart rate in T2DM male subjects, which is a positive indicator of the physical fitness of the diabetic patients.

Twelve weeks aerobic exercise training program was not effective in improving the BMI and body mass in T2DM male subjects.

A larger sample size and a longer duration of such training program may provide give more meaningful data on the effects of aerobic exercise on Type 2 diabetic patients.

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# قياس حجم الاستهلاك الأعلى من الأوكسجين وقياس نبضات القلب الإسترخائي لدى المرضى الذكور المصابين بالنوع الثاني من داء السكر في برنامج تدريبي مدته ١٢ اسبوعاً

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*المستخلص.* ان الهدف من هذه الدراسة البحث في تأثير التمرينات الهوائية على الحد الاعلى لاستهلاك الأوكسجين ونبض القلب في الحالة الاسترخائية ومؤشر كتلة الجسم والوزن لدى الذكور المصابين بالداء السكري من النوع الثاني. تكون البرنامج من اثني عشر اسبوعاً من التدريبات الرياضية الهوائية يشرف عليه اثنين من الاخصائيين في التربية الرياضية. وشملت العينة ١٢ من الذكور المصابين بداء السكري النوع الثاني تراوحت اعمارهم بين ٢٥– ٥٥ سنة. كانت شدة التمارين بين ٤٠ الى ٦٠٪ من الحد الاعلى لنبضات القلب، وكانت مدة التمارين من ٣٠ الى ٤٠ دقيقة ثلاث مرات اسبوعياً طوال فترة البرنامج. اظهرت النتائج ان هناك اختلافاً واضحاً علمياً بين معدلات كمية استهلاك الحد الاقصى للأوكسجين قبل وبعد التمرين وكذلك

معدلات نبضات القلب الاسترخائية. حيث اظهرت النتائج تحسن ملحوظ في معدل استهلاك الحد الاقصى للأوكسجين من ٥٩،٦٦ ± ٤،٣٧ اللى ٦٨،٨٨ ± ٤،٧٣ مل / كغم / دقيقة و بمؤشر دقة اقل من ٠،٠١٦ التحسّن ايضاً لوحظ في معدل نبضات القلب الاسترخائي من ٨٢،٢٨ ± ٩،١٤ الى ٧٤،٤٢ ± ٦،٨٢ نبضة / الدقيقة وبمؤشر دقة اقل من ٠،٠٢٧ النتائج لم تبيّن اي تحسّن في مؤشر كتلة الجسم بمؤشر دقة ١،١٧ او الوزن بمؤشر دقة ٠،٣١٧ الخلاصة ان البرنامج التدريبي للذكور المصابين بداء السكري حسَّن من الحد الاستهلاكي الاعلى للأوكسجين و نبض القلب الاسترخائي ولكن لم يؤثر على انقاص الوزن.