



Effect of a Six-Week Progressive Resistance Exercise Regimen on Limb Muscle Strength and Perceived Fatigue in Adults with Type 2 Diabetes Mellitus

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Abstract: It has been proved that strength is reduced in type 2 diabetes, however not much research is done on the intervention for same. Our study involves evaluating the effectiveness of a progressive resistance exercise regimen to enhance strength, improve overall energy levels and physical function of type 2 diabetic patients using Modified Sphygmomanometer Scale (MSS) and Modified Fatigue Impairment Scale (MFIS). The study design was experimental while the type was intervention. The study was done over the period of 6 months with a sample size of 40 and the study was set up in diabetic clinics in and around Pune. The target population was type 2 diabetics and simple random sampling method was used. The MSS score post protocol had an average increase of 2.7 and 1.85 for upper limb and lower limb respectively, with a p value of <0.0001. The MFIS score showed statistically significant decrease in fatigue of individuals in intervention group on the physical, cognitive and psychological subscales post protocol.

Keywords: Type 2 diabetes, progressive resistance exercise, Modified sphygmomanometer scale, MFIS.

INTRODUCTION

Diabetes mellitus is a clinical syndrome characterized by hyperglycaemia caused by absolute or relative deficiency of insulin. Hyperglycaemia has many causes but is most commonly due to type 1 or type 2 diabetes. It is essential that people with diabetes understand their disorder and learn to handle all aspects of their management as comprehensively and quickly as possible. Ideally, this can be achieved by a multidisciplinary team (doctor, dietician, specialist nurse and a physical therapist).⁽¹⁾

Physical exercise can reduce the amount of glucose in the blood which makes it easier to control your blood glucose level. As discussed above, an impaired glucose level causes systemic changes in the body such as obesity hypertension that can be effectively tackled with regular exercising. Physical

activity is another important determinant of insulin sensitivity. Inactivity is associated with down regulation of insulin-sensitive kinases and may promote accumulation of FFAs (Free fatty acids) within skeletal muscle.⁽¹⁾

Strength training is helpful in obtaining efficient and lean muscles. Along with jogging, and walking adding these resistance-type exercises, will also help in achieving strong and healthy bones. Adding more muscle to replace fat, proves beneficial in patients with type 2 diabetes in particular because muscles utilize the most glucose, so as muscles are used more, you use your muscles, the more effective it can be to control blood glucose level. The most used strength building technique is weight-training although using one's own body weight to increase strength can also be utilized for example pull ups and planks. Twenty to thirty minutes of lifting weights for two to three times in a week is sufficient to gain full benefits of this type of training.⁽²⁾

It is an established fact that diabetics need regular physical exercise for a better quality of life. The question is what is the most effective protocol for a diabetic individual that helps the individual with specific musculoskeletal problems associated with diabetes. For this we need to ascertain what muscle groups are most affected in a diabetic individual and, hence, help us in coming up with a protocol that could be effective to most of the type 2 diabetic population.

Most common muscle groups with reduced strength are plantar flexors comprising of gastrocnemius, soleus, plantaris, and so on; dorsiflexors comprising of the tibialis anterior, the extensor hallucis longus and the extensor digitorum longus; knee extensors comprising chiefly of the quadriceps; knee flexors comprising chiefly of the hamstrings; hip flexors comprising of the rectus femoris, iliacus, psoas, sartorius, and so on; hip extensors comprising of the gluteus maximus and hamstrings of lower limb and intrinsic hand muscles comprising of thenar, adductor pollicis, palmaris brevis, interossei, lumbricals and hypothenar. Limited joint mobility may precede severe upper extremity impairments associated with pain and/or disability. Limited joint mobility and associated impairments of the glenohumeral joint and arm may cause considerable impact on upper limb function in diabetic patients.⁽³⁾

At the beginning, as the limited joint mobility of the shoulder and hand may be painless it can, therefore, go unnoticed. Due to reduced strength and increase in fatigue, the performance of functional physical activities of daily living is impaired. People with diabetes commonly complain of fatigue, which likely hinders the performance of daily activities for management of diabetes. Working on the current problems as well as the average problems faced by diabetic individuals, to help prevent such problems from arising, is important for diabetics.⁽⁴⁾

The role of a physiotherapist in management of diabetes is to counsel patients and provide advice on appropriate and effective exercise, physical conditioning, and active, healthy living. Our study involves evaluating the effectiveness of a progressive resistance exercise regimen to enhance strength, improve overall energy levels and physical function of type 2 diabetic patients.

METHODS

The study design was experimental while the type was intervention. The study was done over the period of 6 months with a sample size of 40 and the study was set up in diabetic clinics in and around Pune. The target population was type 2 diabetics and simple random sampling method was used. The participants included were both genders in the age group of 40-70 years. The BSL >140mg/dl, HbA1c > 7% and subjects diagnosed with diabetes type 2 since 1 year. The participants excluded were those who were not willing, had other systemic illness, had suffered recent injuries, and type 1 diabetics. The outcome measures were Modified Sphygmomanometer Scale (MSS) and Modified Fatigue Impact Scale (MFIS).^(5,6)

PROCEDURE

Permission was taken from the institutional ethical committee. Different centres were approached and permission was taken prior to the study. The experiment was explained to the patient. Patients willing to give consent were included in the study. The protocol was explained to the participants.

A pilot study was conducted and errors would be resolved with help of the guide. The patients were assessed for strength using Modified Sphygmomanometer Scale. The patients were assessed for fatigue using Modified Fatigue Impairment scale. There were two groups of patients, a control group and intervention group.

The intervention group (Group A) of 40 individuals was given the protocol for strength training. The protocol [table below] involves a session of 30-45 minutes that were given for 3 non-consecutive days in a week. The protocol was followed for 6 weeks. There were 3 sets of 10 minutes for resistance exercises of upper limb and lower limb. The exercises were performed after a warm up and ended with cool down exercises. The strengthening protocol would include exercises for knee extensors, leg press, bicep curl, triceps extension, shoulder press, seated bench press. The repetition of exercise was progressed to increasing sets after the patients were able to perform a set of 10 repetitions respectively.

The patients were assessed using modified sphygmomanometer test at 0, 1, 3, and 6 weeks of the intervention and readings were noted for upper limb assessment, the cuff was wrapped at the distal aspect of the arm and the cuff was inflated to 20 mmHg pressure. The individual was then asked to perform isometric contraction of the limb and the rise in pressure was noted. 3 consecutive readings were taken and the average was taken as the final reading.

For assessment of the lower limb, the cuff was wrapped around distal aspect of the leg and the cuff was inflated to 20 mmHg pressure. The individual was then asked to perform isometric contraction of the limb and the rise in pressure was noted. 3 consecutive readings were taken as the final reading. Data was collected and statistical analysis was done.

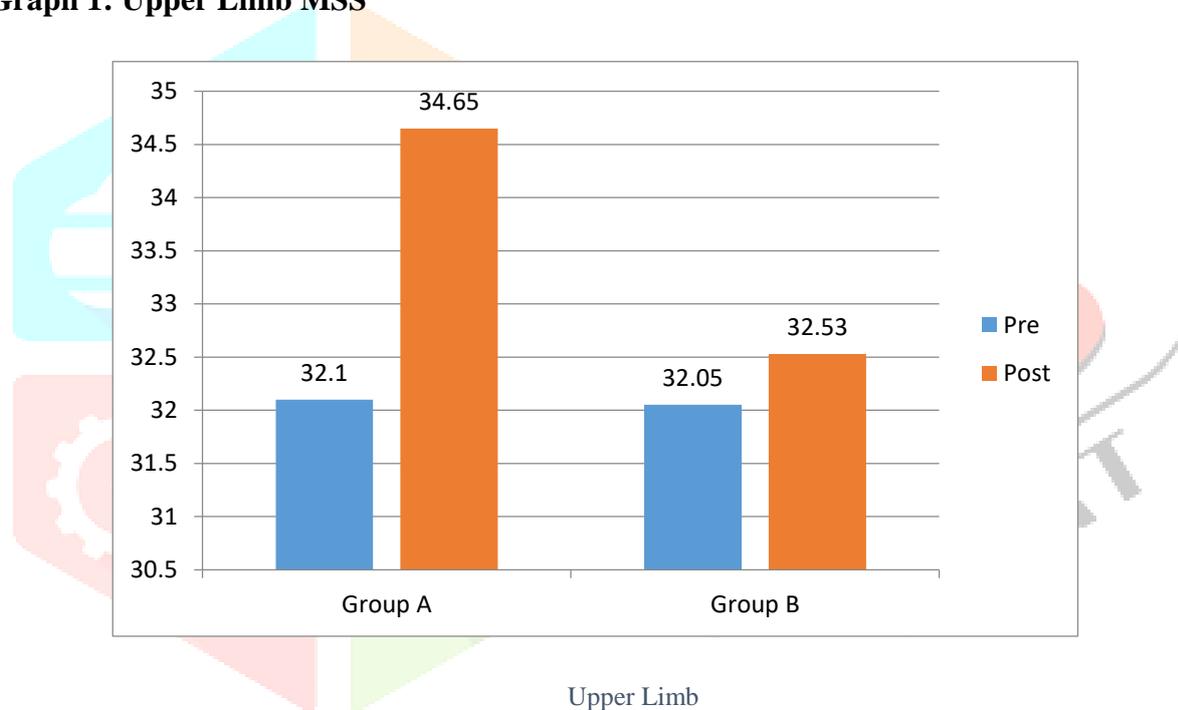
Exercise	Volume
Calf raises	2 sets and 10 repetitions 10 seconds rest between sets.
Squatting	2 sets and 10 repetitions 10 seconds rest between sets.
Hamstring curls (with weight cuffs)	2 sets and 10 repetitions 10 seconds rest between sets.
SLRs (with weight cuffs)	2 sets and 10 repetitions 10 seconds rest between sets.
Biceps curls (with dumbbell)	2 sets and 10 repetitions 10 seconds rest between sets
Triceps curls (with dumbbell)	2 sets and 10 repetitions 10 seconds rest between sets

Results

Table 1: Comparison of Group A and Group B for MSS.

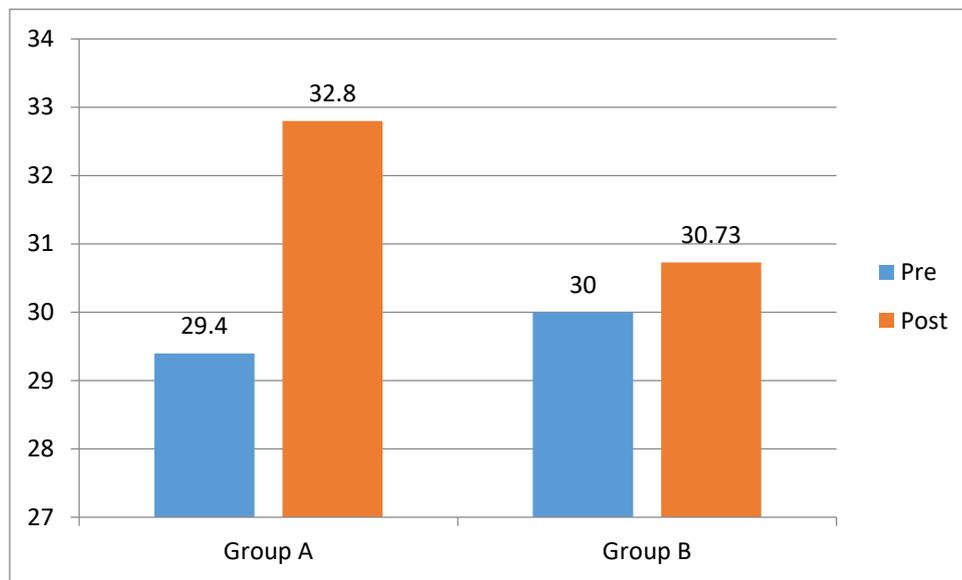
MSS	Group A	Group B	p-value
Upper limb pre	29.4 ±1.9	29.5 ±1.3	<0.0001
Upper limb post	32.1 ±2.7	29.8 ±1.5	
p value	<0.0001	0.8804	
Lower limb pre	32.8 ±2.63	32.3 ±2.43	<0.0001
Lower Limb post	34.65 ±2.57	32.4 ±2.78	
p value	<0.0001	0.7624	

Graph 1: Upper Limb MSS



Interpretation: There is increase in the strength of the upper limb muscle in Group A (Progressive Resistance exercise) as compared to Group B (Control Group) with p value <0.0001.

Graph 2: Lower Limb MSS



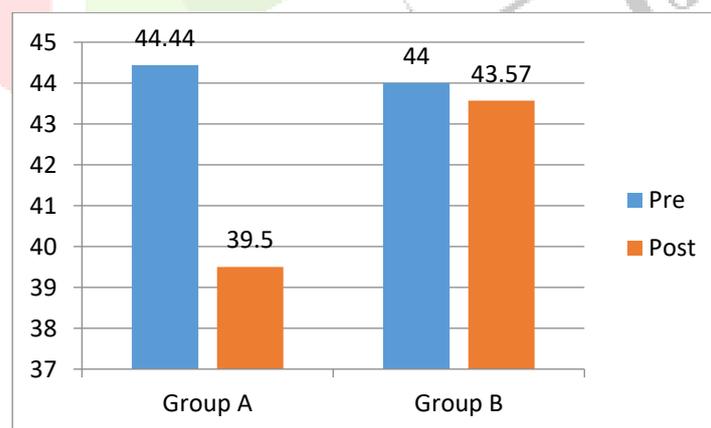
Lower Limb

Interpretation: There is increase in the strength of the lower limb muscle in Group A (Progressive Resistance Exercise) as compared to Group B (Control Group) with p value <0.0001.

Table 2: Comparison of Group A and Group B for MFIS.

MFIS	Group A	Group B	p value
Pre	44.4 ±1.6	44 ±1.7	<0.0001
Post	39.5 ±1.8	43.7 ±1.9	
p value	<0.0001	0.64	

Graph 3



MFIS

Interpretation: There is statistically significant decrease in fatigue of individuals in Group A(Progressive resistance exercise Group) compared to Group B(Control Group) on the physical, cognitive and psychological subscales by MFIS.

DISCUSSION

The records until 2017 suggest that, about 425 million people had diabetes worldwide and type 2 diabetes mellitus counted upto 90% of the cases. It is a proven fact based on many researches that there is significant reduction in muscle strength of a diabetic individual making them more susceptible to impaired muscle function. Even though the problem is well known there are limited studies dedicated to counter it.⁽⁷⁾

In our study, we devised a progressive resistance exercise regimen to enhance strength, improve overall energy levels and physical function of type 2 diabetic patients and evaluate its effectiveness. The participants were selected with the exclusion criteria for type 1 diabetic patients. The mean age of the participants in group A was about 55 ± 2 years while 22 males and 18 females participated in the study. The mean age of the participants in group B was about 53 ± 4 years while 24 males and 16 females participated in the study.

All the subjects were assessed prior and after the protocol was implemented using two outcome measures namely Modified Sphygmomanometer Scale and Modified Fatigue Impairment Scale validity. After 6 weeks of implementing the protocol, the results showed that there is increase in the strength of the upper limb and lower limb muscles evident from the values of modified sphygmomanometer scale. For upper limb the p value was 0.0482 and, hence, the value is statistically not significant. As for the lower limb the p value was 0.8804 and, hence, statistically the value was not found to be significant.

According to the MFIS there is reduced effect of fatigue on the physical, cognitive and psychological subscales. Although, the p value for MFIS was found to be 0.6430 and, hence, the values were statistically significant. There is decrease in fatigue, limitations due to emotional and physical problems. No significant difference in Pain and physical functioning is noted.

The results in our study show that a Progressive Resisted exercise protocol is effective for type 2 diabetic patients. Both the outcome measures used in pre and post assessment of the subjects showed positive results and were statistically significant. Our results support the study done by Sheri R. Colberg where exercise was found to have an essential role in the prophylaxis and control of insulin resistance, prediabetes, gestational diabetes mellitus, type 2 diabetes mellitus, and associated complications of diabetes mellitus.⁽⁸⁾

In our protocol we included the resistance exercises for the muscle groups most affected in type 2 diabetic patients. In a study it was found that upper extremity impairments in patients with diabetes were common, severe and related to complaints of pain and disability. Limited joint mobility in diabetes is thought to be caused by non-inflammatory thickening and increased stiffness in the peri-articular structures. Most common muscle groups with reduced strength are plantar flexors comprising of gastrocnemius, soleus, plantaris, and so on; dorsiflexors comprising of the tibialis anterior, the extensor hallucis longus and the extensor digitorum longus; knee extensors comprising chiefly of the quadriceps; knee flexors comprising chiefly of the hamstrings; hip flexors comprising of the rectus femoris, iliacus, psoas, sartorius, and so on; hip extensors comprising of the gluteus maximus and hamstrings of lower limb and intrinsic hand muscles comprising of thenar, adductor pollicis, palmaris brevis, interossei, lumbricals and hypothenar. Hence, our protocol was designed strategically to enhance strength in these muscles except the intrinsic hand muscles due to limited resources. Further studies need to be carried out where intrinsic hand muscles are progressively strengthened by resistance exercises as this group of muscles holds a lot of significance in functional conditioning of a diabetic.⁽³⁾

In a study done by Karam Padma and colleagues called 'Evaluation of knowledge and self care practices in diabetic patients and their role in disease management' it was found that patients who were regularly involved in self care practices have achieved better glycemic control. Poor awareness and practices among diabetic patients are some of the important variables influencing the progression of diabetes and its complications, which are largely preventable. Compared with the general population incidence of Coronary heart diseases and stroke are more among patients of diabetes. It is important to note that self care and exercising could go a long way in improving the health of a diabetic individual.

In the same study it was also found that the awareness among the diabetic population for the importance of exercise is quite decent as suggested by the finding wherein 71 out of 117 patients (61.68%) were well aware of the importance and the role of exercise in managing diabetes. Hence, regular inculcation of health education, making the patient aware regarding the disease and encouraging self-care management during treatment will reduce health care burden and help achieve optimal control of the disease with minimal long-term complications.⁽⁹⁾

The volume of the exercise prescription was determined after reviewing various studies. One such study was done by Matthew D. Hordern and colleagues where they recommended that patients with type 2 diabetes mellitus accumulate a minimum of 210 min per week of moderate-intensity exercise or 125 min per week of vigorous intensity exercise with no more than two consecutive days without training. Vigorous intensity exercise is more time efficient and may also result in greater benefits in appropriate individuals with consideration of complications and contraindications. It is further recommended that two or more resistance training sessions per week (2–4 sets of 8–10 repetitions) should be included in the total 210 or 125 min of moderate or vigorous exercise, respectively.⁽¹⁰⁾

CONCLUSION: There is significant effect of Progressive Resistance exercises on upper limb and lower limb strength as well as, there was positive result on fatigue reduction in type 2 diabetic patients.

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