

Research article

A study to analyze the effectiveness of Swiss ball exercise versus resistance training in type 2 diabetes mellitusKamatchi Kaviraja¹, Arimbit K. Sangma², Priya Kumara³, N. Kaviraja⁴, S. Jennifer Agustina⁵¹Assistant Professor, ²Faculty of Physiotherapy, Dr. MGR Educational and Research Institute, Chennai, Tamil Nadu, India³Assistant Professor, Vels Institute of Science and Technology, Pallavaram, Chennai, Tamil Nadu, India⁴Pediatric developmental Therapist, Kavi's Physiotherapy and Pediatric Therapy Clinic, Avadi, Chennai, Tamil Nadu, India⁵Assistant Professor, Saveetha College of Physiotherapy, Thandalam, Chennai, Tamil Nadu, India

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Corresponding author: **Kamatchi Kaviraja**. Email: kamatchi.physio@drmgrdu.ac.in**ABSTRACT**

Introduction and Aim: Diabetes is a disease rising all over the world affecting larger number of populations. In India largest number of diabetic patients are reported. Lack of physical activity, dietary pattern change, and sedentary life style are the major causes for concern. An effective lifestyle intervention including changes in dietary pattern, regular exercises would enhance in preventing or postponing the onset of diabetes. The aim of the study is to analyse the effectiveness of Swiss ball exercise and resistance training in type 2 diabetes mellitus patients.

Materials and Methods: The study design is comparative type. The study was conducted in Faculty of Physiotherapy, Dr. MGR Educational and Research Institute, Chennai. The study sample of 30 subjects both male and female were selected based on the inclusion and exclusion criteria. The subjects were sorted into two groups. Inclusion criteria were patients with clear history of Type 2 diabetes, clinically diagnosed, an inactive lifestyle, age between 30-60 years. Exclusion criteria were uncontrolled hypertension, coronary artery disease, advanced retinopathy, neuropathy, severe orthopedic conditions. 30 subjects between the age group of 30-60 years were divided into two groups, group A and group B. Individuals in the group A (n=15) received the Swiss ball exercise and group B (n=15) received resistance training exercise for 5 session/ week for 12 weeks for 30 minutes.

Results: On comparing pre-test and post-test within group A and group B on fasting, post prandial blood sugar level and diabetes distress screening scale show highly significant difference in mean values at $P \leq 0.001$.

Conclusion: The study concluded that both the groups had substantial effect. On comparing Swiss ball exercise and resistance training, both the exercise programs were found to be equally effective.

Keywords: FBS; PPBS; dietary habits; sedentary lifestyle.

INTRODUCTION

The person affected with diabetes continues to increase worldwide (1, 2). Diabetes, a metabolic disorder characterized by hyperglycaemia is divided into two types. Type 1 diabetes develops when the pancreas fails to secrete insulin, and type 2 diabetes develops when the pancreas retains some capacity to secrete insulin but insulin resistance for a variety of reasons (3, 4). Type 2 diabetes mellitus and pre-diabetic conditions such as impaired glucose tolerance is characterized by varying levels of insulin resistance causing hyperglycaemia. The change in glucose and insulin metabolism may not be a normal characteristic of aging but it is associated with obesity and physical inactivity (5).

Late-stage diabetes is associated with multiple chronic complication that led to extremely high rates of mortality and disability. The pathogenic mechanism is always associated with hereditary and environmental factors the disease has recently been detected as a chronic low-grade inflammatory disease its onset is characterized with persistent low-grade inflammation (6). There is significant elevation of

tumor necrosis factor-alpha (TNF- α), interleukin (IL)-6, C-reactive protein in diabetes (7).

The person affected with diabetes is rapidly increasing worldwide. India is the largest number of diabetic patients (40.9 million). Reduced physical activity, changes in dietary pattern, and pattern, and sedentary life style are the major causes for Diabetes (8). Lifestyle interventions including changes in dietary pattern, regular exercises would greatly help in preventing and postponing the onset of diabetes and reducing the burden on society and nation (9).

Insulin resistance plays a key role in the development of type 2 diabetes and patient will develop dyslipidaemia hypertension, and developing the risk of cardiovascular disease. This leads to damage of autonomic nerves distributed in the heart and blood vessels in patients with type 2 diabetes, which leads to cardiovascular autonomic neuropathy, increasing the risks of death (10).

Exercise as an ability to reduce the systemic low-grade inflammation in chronic inflammatory diseases such as obesity, metabolic syndrome, diabetes mellitus, ageing etc. It will reduce the levels of

inflammatory factors such as TNF- α , IL-6, CRP, and leptin and increase the levels of anti-inflammatory factors such as IL-4, IL-10 and adiponectin in diabetes patients. Exercise will reduce the inflammation level and improves IR by enhancing anti-stress and anti-oxidative effects (11).

World Health Organization (WHO) forecasts that in 2030, diabetes will become the 7th leading cause of death (12). Type 2 diabetes is associated with people with lack of physical fitness, and people with this chronic disease have lower exercise tolerance than people without diabetes (13). People with T2DM develops insulin resistance in skeletal muscle characterized by build-up of intramuscular triglyceride and lack of mitochondrial function and this dysfunction is the major cause of T2DM (14). Glycaemic control improves with stability ball exercises among type 2 diabetes mellitus (15). Swiss ball exercises are widely used because they can improve strength, endurance, flexibility, coordination and balance (16).

It was in 1990 when the American College of Sports Medicine recognized RT as a contributing factor to a comprehension fitness program for healthy adults of all ages. The current position statement for exercise and type 2 diabetes by the ACSM and the American Diabetes Association recognize the beneficial effects of RT and recommends RT at least twice a week in addition to aerobic training for persons with T2DM. Recent evidence indicates that RT has the power to combat metabolic dysfunction in obese, T2DM patients. Resistance training may assist prevention and management of T2DM by decreasing visceral fat and inflammatory markers. Resistance training can improve glycemic control and insulin sensitivity (5). Hyperglycemia in patients with diabetes mellitus needs scientific approach for effective treatment. Resistance training and Swiss ball exercise which employs principles of work can benefit glycemic control. Hence, it is imperative to study the effect of resistance training and Swiss ball exercise on patients with diabetes mellitus.

MATERIALS AND METHODS

Study design: Experimental; Study type: Comparative pre and post study; Study setting: Kanchipuram district village

Sample size: 30 subjects both male and female between the age 30 to 60 years; Study duration: 12 weeks 5 sessions per week for 30 mins.

Inclusion criteria: Type 2 diabetes mellitus clinically diagnosed patients, male and female between 30 to 60 years those who are interested, FBS above 126 mg/dL.

Exclusion criteria: PPBS above 250 mg/dL, uncontrolled hypertension, stroke.

- Peripheral vascular disease

- Neuropathy
- Advanced retinopathy
- Coronary artery disease
- Cataracts
- Patients' refusal to participate in this study

Instruments used: Swiss ball, Thera band.

Outcome measures:

- Fasting blood sugar test
- Postprandial glucose test
- Diabetes distress screening scale.

Procedure

The exercise regimen was done in a community hall in the village. 30 subjects were selected based on the inclusion and exclusion criteria. They were given a consent form and the exercises were carried out after having the patients assessed for 12 weeks, 5 sessions per week for 30 minutes. The subjects were randomly assigned to two groups.

1. Group A (Swiss ball)

- Ball wall squat
- Ball pelvic bridge
- Trunk extension
- Superman exercise

2. Group B (Resistance training)

- Straight arm pulls
- Opposite diagonal arm pulls
- Seated elbow flexion
- Triceps extension
- Unilateral raise
- Wrist extension

Pre and post-test were done by using fasting blood sugar and post prandial blood sugar and diabetes distress screening scale.

Group A: Swiss ball

- **Ball wall slide:** The patient was instructed to place the swiss ball on the lower back by placing the hands by the hips. Then the patient was asked to brace the abs and squat down to the finish position, keeping the knees over the toes. Ultimately, the patient attempted to push through the heels and return to a standing position.
- **Ball pelvic bridge:** The patient was instructed to lie on back with arms next to sides and straight legs on the ball and he was asked to push the legs into the ball and lift pelvis off the floor until the body was diagonal from shoulders to feet and held for 10 seconds.
- **Wall trunk extension:** The patient was instructed to get down on her knees and lie on the ball under the abdomen with the feet

placed against the wall. The patient was asked to lift her upper body from the ball until her spine was slightly extended.

- **Superman:** The patient was instructed to stand on all fours with the ball under the abdomen. Then, the patient was asked to slowly raise and stretch out the right arm and left leg until it was in line with the rest of the body and was held for 10 seconds.

Group B: Resistance training

Straight arm pulls: The patient was instructed to keep the arms straight forward and hold hand with both hands about shoulder width apart. Then, the patient was asked to stretch the band apart keeping the arms straight and held for 10 seconds and return to the same position.

Opposite diagonal pulls: The patient was instructed to imagine the face of a clock to help him position arm properly and was asked to hold the band in his right at 2oclock and the other end of the band in the left hand at 8oclock keeping the elbows straight by slowly stretching the band.

Seated elbow flexion: The patient was instructed to securely step on one end of the Thera Band and asked to bend the elbow up toward his shoulder and held for 10 seconds and slowly return to starting position. The exercise was repeated for 10 times.

Triceps extension: The patient was asked to stand with feet shoulder-width apart, knees soft and abdominals tight. Then, the patient was asked to grasp the band on either end, placing one hand

behind the back with the hand against the waistline. The patient was asked to extend the top arm above the head by moving just the elbow.

Unilateral raise: The patient was asked to stand with feet shoulder-width apart placing one end of the band under the left foot by grasping the other end of the band in the left hand, maintaining a slight bend in the elbow and was asked to lift the hand.

Wrist pull ups: The patient was asked to fold the band and hold in the middle with the top band with the palm down. With the opposite hand, holding the ends of the band tightly. Then, the patient was asked to pull up the wrist keeping elbow tucked into side.

Data analysis

The collected data were tabulated and analyzed using both descriptive and inferential statistics. All the parameters were assessed using statistical package for social science (SPSS) version 24. Paired t-test was adopted to find the statistical difference within the groups and Independent 't' test (Student 't' Test) was adopted to find statistical difference between the groups.

Ethical clearance

The study procedures were performed according to the recommendations of Helsinki Declaration of 1964 (as revised in 2008). This study was registered under Faculty of Physiotherapy, Dr. MGR educational and Research institute with [D-05/PHYSIO/IRB/2018-2019]. The study was carried out during November 2018 to June 2019.

RESULTS

Table 1: Comparison of fasting blood sugar (FBS) level between group A and group B in pre and post tests

#FBS	#Group A		#Group B		t test	df	Significance
	Mean	S. D.	Mean	S. D.			
Pre-test	166.86	14.16	166.13	12.48	.151	28	.881*
Post test	145.80	14.50	144.13	12.46	.338	28	.738*

(* - $P > 0.05$)

The above table reveals the Mean, Standard Deviation (S.D.), t-test, degree of freedom(df) and p-value between group A and group B in pre-test and

post-test weeks. This table shows that there is no significant difference in pretest and post-test values between group A and group B (* $P > 0.05$).

Table 2: Comparison of post prandial blood sugar (PPBS) level between group A and group B in pre and post test

#PPBS	#Group A		#Group B		t test	df	Significance
	Mean	S. D.	Mean	S. D.			
Pre-test	186.06	14.29	184.13	12.48	.395	28	.696*
Post test	160.60	14.25	158.13	12.46	.505	28	.618*

(* - $P > 0.05$)

The above table reveals the Mean, Standard Deviation (S.D), t-test, degree of freedom(df) and p-value between group A and group B in pre-test and post-test weeks. This table shows that there is no

significant difference in pretest & posttest values between group A and group B (* $P > 0.05$).

Table 3: Comparison of diabetes distress screening scale (DDSS) between group A and group B in pre and post test

#DDSS	#Group A		#Group B		t test	df	Significance
	Mean	S. D.	Mean	S. D.			
Pre-test	3.23	.269	3.18	.399	.375	28	.710*
Post test	2.20	.286	2.15	.277	.518	28	.609*

(*- $P > 0.05$)

The above table reveals the Mean, Standard Deviation (S.D.), t-test, degree of freedom(df) and p-value between (Group A) and (Group B) in pre-test and post-test weeks. This table shows that there is no

significant difference in pretest and post-test values between group A and group B (* $P > 0.05$).

Table 4: Comparison of fasting blood sugar level within group A and group B between pre and post-test values

#FBS	Pre-test		Post test		t test	Significance
	Mean	S. D.	Mean	S. D.		
Group A	166.86	14.16	145.80	14.50	115.94	.000***
Group B	166.13	12.48	144.13	12.46	189.05	.000***

(***- $P \leq 0.001$)

The above table reveals the Mean, Standard Deviation (S.D.), t-value and p-value between pre-test and post-test within group A and group B. There

is a statistically high significant difference between the pretest and posttest values within group A and group B (***- $P \leq 0.001$).

Table 5: Comparison of post prandial blood sugar level within group A and group B between pre and post-test values

#PPBS	Pre-test		Post test		t test	Significance
	Mean	S. D.	Mean	S. D.		
Group A	186.06	14.29	160.60	14.25	191.00	.000***
Group B	184.13	12.48	158.13	12.46	389.00	.000***

(***- $P \leq 0.001$)

The above table reveals the Mean, Standard Deviation (S.D.), t-value and p-value between pre-test and post-test within group A and group B. There

is a statistically high significant difference between the pretest and posttest values within group A and group B (***- $P \leq 0.001$).

Table 6: Comparison of diabetes distress screening scale within group A and group B between pre and post-test values

#DDSS	Pre-test		Post test		t test	Significance
	Mean	S. D.	Mean	S. D.		
Group A	3.23	.269	2.20	.286	24.48	.000***
Group B	3.18	.399	2.15	.277	12.42	.000***

(***- $P \leq 0.001$)

The above table reveals the Mean, Standard Deviation (S.D.), t-value and p-value between pre-test and post-test within group A and group B. There is a statistically highly significant difference between the pretest and post-test values within group A and group B (***- $P \leq 0.001$)

DISCUSSION

Exercise therapy is an effective method for treating diabetes mellitus. Among diabetes patients, regular exercise has a better blood glucose controlling effect, because it improves insulin sensitivity. The aim was to compare the effects of Swiss ball exercise and resistance training in subjects diagnosed with T2DM. The principle finding of the present study was that both the Swiss ball and resistance training were equally effective in type 2 diabetes mellitus patients. This research confirms that following SBEs and

Resistance training significant improvement was observed in FBS, PPBS and Diabetes Distress Screening Scale in both the groups. The sample size of the study was 15 each respectively. Both showed similar results. However, the results were not obvious in either direction regarding the comparison of both the groups.

Nonetheless, moderate intensity resistance training results in a mean reduction of glycolate hemoglobin by 1% to 2% (17). Resistance training involving major muscle groups has been shown to improve glycemic control and reduced FBS levels (18). Glycemic control improves with resistance training involving major muscle groups (8). As physio ball exercises involve dynamic muscle loading (from body weight) causing muscle contractions which help to increase muscle strength, power and endurance, hence improved well beingness (19). Exercises using

stability ball were effective in improving core strength, endurance and balance in sedentary women (20).

In the present study, group A which underwent Swiss ball exercise had significant improvement in glycemic control of diabetic patients. The group B which underwent resistance training had also significant improvement in glycemic control in diabetic patients. Both the exercise programs were found to be effective in reducing glycemic control in patients with type 2 diabetes mellitus; however, there was no significant difference in the comparison between the two-exercise program.

There is a statistically high significant difference between the pre-test and post-test values within group A and group B in diabetic patients ($P < 0.001$).

According to the results of the current review, both Swiss ball and Resistance training have effects on metabolic control, but only if maintained in sufficient levels over time. FBS and PPBS mean values have decreased among pre and post-test values of SBE and resistance training group; this is highly significant at 10% probability level with $P < 0.001$. Hence, Swiss ball and resistance training can form a modality in the comprehension management of type 2 diabetes mellitus.

CONCLUSION

This study concluded that Swiss ball and resistance training are both equally effective in glycemic control of Type 2 diabetic mellitus patients and can be used in the comprehensive diabetic care, which is time-conserving and cost effective. There is also a good evidence that resistance training improves insulin sensitivity and glucose tolerance, and Swiss ball exercises which showed improved glycemic control among type 2 diabetic patients is also a worthy indicator of a new physical modality to be deployed in the overall diabetic care.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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