



EFFECT OF A NOVEL STRUCTURED THERAPEUTIC EXERCISE PROGRAM ON BLOOD GLUCOSE LEVELS IN INDIVIDUALS SUFFERING FROM DIABETES MELLITUS TYPE 2

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ABSTRACT

INTRODUCTION

Diabetes Mellitus Type 2 (DM2) is a chronic condition associated with elevated blood glucose levels. Exercise has shown to have a prognostic effect on reducing the blood glucose levels among individuals suffering from DM2. But, there is a need to study the effect of a novel unique structured therapeutic exercise program on blood glucose levels among individuals suffering from DM2.

MATERIALS AND METHODS

A Pre Study – Post Study design research study was carried among individuals suffering from DM2. A novel unique structured therapeutic exercise program at a moderate intensity as per the Rate of Perceived (RPE) Scale as an intervention was delivered to 30 participants suffering from DM2. Fasting Blood Glucose (mg/dL), Fasting Blood Glucose (mmol/L) and HbA_{1c} (%) are outcome measures that were used to assess the blood glucose levels among the 30 participants suffering from DM2.

RESULTS

A lowering of blood glucose levels were seen among the participants in this study.

DISCUSSION

This reduction in blood glucose levels could be attributed to the increased physical activity, increased glucose uptake due to the novel unique therapeutic exercise program.

CONCLUSION

Thus, we conclude that a novel unique structured therapeutic exercise performed at moderate intensity as per the Rate of Perceived Exertion (RPE) scale helped reduce the blood glucose levels among individuals suffering from DM2.

Key words: Therapeutic Exercises, Diabetes Mellitus Type 2

MANUSCRIPT

INTRODUCTION

Diabetes Mellitus Type 2 (DM2) is soon becoming known in the international health agenda as a global pandemic which is threatening the human health globally on a large extent. During the last two decades the global population suffering from DM2 has nearly doubled.¹ As per International Diabetes Federation 415 million people are suffering from DM2 in 2015 and it is estimated by the year 2040 this number to rise up to 642 million.² Close to 77 million people in India suffer from DM2 in the year 2019. And, it is estimated by the year 2030, this number to increase to 101 million and by 2045 to increase to 134 million.³

The United Nations Sustainable Development Goals envisage on lowering the number of premature deaths caused due to DM2 to one-third by 2030. Similarly, India's national health policy too intends to enhance screening and treatment of those individuals suffering from DM2 by 80% and 25% respectively.³

A malfunctioning in the feedback loops between insulin action and insulin secretion results in abnormally high glucose levels in blood in DM2.⁴ DM2 is managed non-pharmacologically with the help of a strict diet and exercise as well as by consumption of anti-hyperglycaemic pharmacological therapy.⁵

Globally, studies suggest that exercise helps in normalizing the blood glucose levels among individuals suffering from DM2.⁶ Also, structured exercise programs too have shown a prognostic effect on blood glucose levels among individuals suffering from DM2.⁷ There is a need to design a novel unique therapeutic exercise program for rehabilitation of individuals suffering from DM2.⁸ Therefore, we opted to study the effect of a novel unique therapeutic exercise program on blood glucose levels in individuals suffering from DM2.

MATERIALS AND METHODS

Firstly, an ethical approval was taken from an Institutional Ethical Committee. Those participants who were diagnosed cases of DM2 and gave consent to participate in this pre test – post test study were included in the study. 30 participants were included in this study.

Participants were included if:-⁸

1. Adult Males
2. Individuals diagnosed with DM2 for more than 6 months (Fasting Plasma Glucose >126 mg/dL < 280mg/dL; HbA_{1c}> 6.5% < 15.6%)
3. Age between 35 to 55 years
4. Individual on Normal Blood Glucose concentration lowering medications

Participants was excluded if: - ⁸

1. Individuals having a difficulty in attaining sitting position for 30 minutes.
2. Suffering from acute fractures in the spinal region.
3. Individuals with musculoskeletal disorders like strains, sprains, fractures causing an impairment to perform physical activity.
4. Suffering from cardio-vascular disorders.
5. Suffering from neurological disorders.
6. Individuals with DM2 suffering from foot ulcers
7. Individuals undergoing any other form of exercise training
8. Individuals who are hypoglycemic
9. Individuals who are handicapped
10. Females or Transgenders or Non-adult males
11. Individuals who are suffering from cancer
12. Individuals who are having sensory impairment
13. Individuals suffering from Kidney dysfunction or disorders
14. Individuals with pacemaker
15. Individuals with implants of gel or silicon and / or transplant organs

Eligible participants were identified by the primary researcher and treating physiotherapist. The primary researcher informed the participant about the study, give them the patient information sheet and provide an explanation about the study in brief. The primary researcher would discuss any questions or queries with the participants. ⁸

Baseline and all follow –up assessments of Fasting Blood Glucose (mmol/L) and Fasting Blood Glucose (mg/dL), and HbA1c (%) levels were collected by a trained pathologist who was blinded about the type of study being carried out. The Consultant Diabetologist or General Medicine Practitioner or Consultant Endocrinologist who diagnosed the participant as Diabetes Mellitus Type 2 and refer the participant for Diabetic Rehabilitation to the Out-Patient Physiotherapy Department. All participants would attend daily physiotherapy sessions for 12 weeks except on Sundays for diabetic rehabilitation program. ⁸

The Consultant Diabetologist certified if the participant was fit to participate in the Therapeutic Exercise program for the rehabilitation of individuals suffering from DM2.

Interventions

Therapeutic Exercises

Therapeutic Exercises will be provided to both all participants in this study in an Out-Patient Physiotherapy Department. Under the therapeutic exercises diabetic rehabilitation, the participants attended daily physiotherapy sessions for 12 weeks except on Sundays for the diabetic rehabilitation programme.

Therapeutic Exercise Programme: To be followed for 3 days per week on alternate days for 12 weeks

Table 1: Therapeutic Exercise Programme⁸

Day	Exercise Type
Monday	Aerobic Exercise
Tuesday	Free Exercises
Wednesday	Aerobic Exercise
Thursday	Free Exercises
Friday	Aerobic Exercise
Saturday	Free Exercises

Warm Up: General range of motion exercises for all peripheral joints.

Aerobic Exercises

Each activity in the sequence will be repeated 8 times and each sequence will be performed for 3 sets.

Table 2:Week wise sequence of aerobic exercises⁸

Sequence 1	Sequence 2	Sequence 3	Sequence 4	Sequence 5	Sequence 6
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
Tap Outs	Side Step	Wide squat throw ball forward	Medicine ball diagonal pattern down to up	Mini Squat	Step Knee down down
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
Skater - Tap behind foot	Knee up	Wide squat throw ball diagonally upwards	Medicine ball diagonal pattern up to down	Mini Squat Punch forward with alternate hands	Step Ham Curl down down
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
Side Steps	Knee Up with hand rotation to same side	Wide squat throw ball diagonally downwards	Medicine ball chest throw	Mini Squat Punch Upward with alternate hands	Step leg back down down
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
‘V’ Walks	Kick forward	Wide squat throw ball upward	Oblique"s- Side to Side	Punch downward with alternate hands	Step kick forward down down
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
High Knees	Kick forward with arms outstretched	Wide squat throw ball sideways	Triceps Throw	Punch Sideways alternately in each direction	Step leg sideways down down
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
Kick Forward	Knee Up with Pull down	Wide squat bounce ball on ground	Biceps Throw	Punch Sideways Up with alternate hands	
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	
Knee Curls	Squat			Punch Sideways Down with alternate hands	
Spot Walking	Spot Walking			Spot Walking	
				Punch	

				Sideways Behind with alternate hands	
				Spot Walking	

Table 3: Free Exercises for the core muscles to be performed every Tuesday for 12 weeks⁸

Sr. No.	Exercise	Hold	Rest
1	Pelvic Bridging	8 seconds	3 seconds
2	Supine Straight Leg Raise	8 seconds	3 seconds
3	Quadripod - Raise 1 upper extremity alternatively	8 seconds	3 seconds
4	Quadripod - Raise 1 lower extremity	8 seconds	3 seconds
5	Bird Dog	8 seconds	3 seconds
6	Modified Crunches	8seconds	3 seconds

Table 4: Upper extremity resisted exercises to be performed on every Thursday and lower extremity resisted exercises to be performed on every Saturday for 12 weeks.⁸

Sr. No.	Exercise	Hold	Rest
Upper Extremity			
1	Shoulder Flexion to 90 degree	8 seconds	3 seconds
2	Shoulder Abduction to 90 degree	8seconds	3 seconds
3	Bicep Curls	8 seconds	3 seconds
4	Tricep Curls	8 seconds	3 seconds
5	Wrist Curls- Flexion	8 seconds	3 seconds
6	Wrist Curls - Extension	8 seconds	3 seconds
Lower Extremity			
7	Dynamic Quadriceps	8 seconds	3 seconds
8	Hip Flexion above 90 degree in sitting	8 seconds	3 seconds
9	Side Lying Straight Leg Raise	8 seconds	3 seconds
10	Hamstring Curls	8 seconds	3 seconds
11	Heel Raises	8 seconds	3 seconds
12	Toe Raise	8 seconds	3 seconds

Table 5: Progression of Free exercises week wise is as follows:-⁸

Week	Repetitions
1 - 3	5
4-6	8
7-9	10
10-12	12

Cool Down: Followed with a cool down period 5 minutes of Savasana.⁸

The novel unique structured therapeutic exercises were performed at a moderate intensity of 12 – 13 on the Rate of Perceived Exertion (RPE) Scale.⁹ The participant was regularly asked while performing the therapeutic exercises about the perceived exercise intensity as per the Rate of Perceived Exertion (RPE) Scale.¹⁰ After every 24 sessions at week 4, week 8 and week 12 post admission to diabetic rehabilitation program the outcome measures were reassessed to check for changes in blood glucose parameters.⁸ A set guidelines for precautions, safety and termination criteria of therapeutic exercise session were followed.⁸

Results

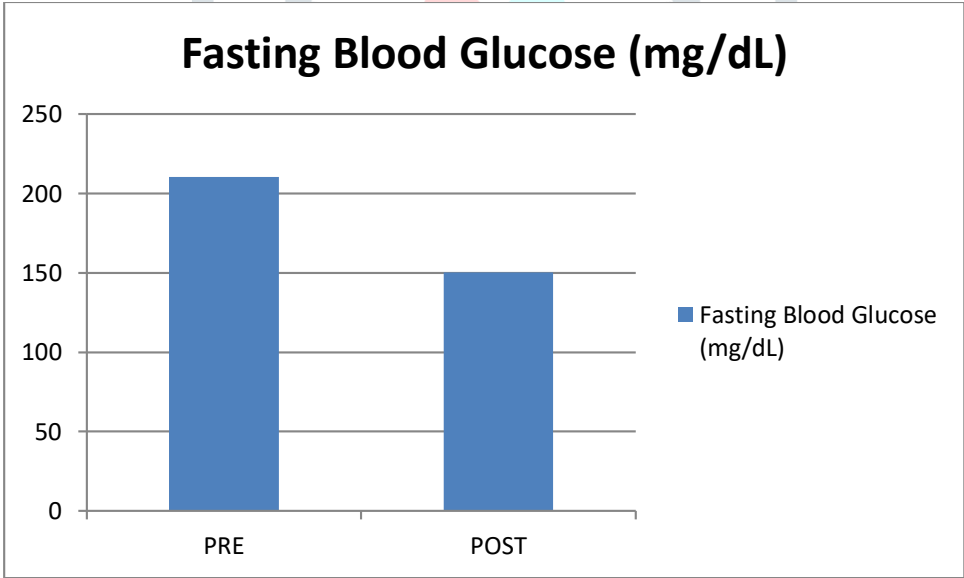
The pre intervention and post intervention of fasting blood glucose (mmol/L), fasting blood glucose (mg/dL) and HbA_{1c} (%) levels were collected and the data was statistically analysed. The data was analysed for normality and paired sample t tests were used for normally distributed changes. Mean changes with 95% confidence intervals (CI) were reported. A 5% level of significance were used for all tests

Table 6: Baseline characteristics of Participants in the study

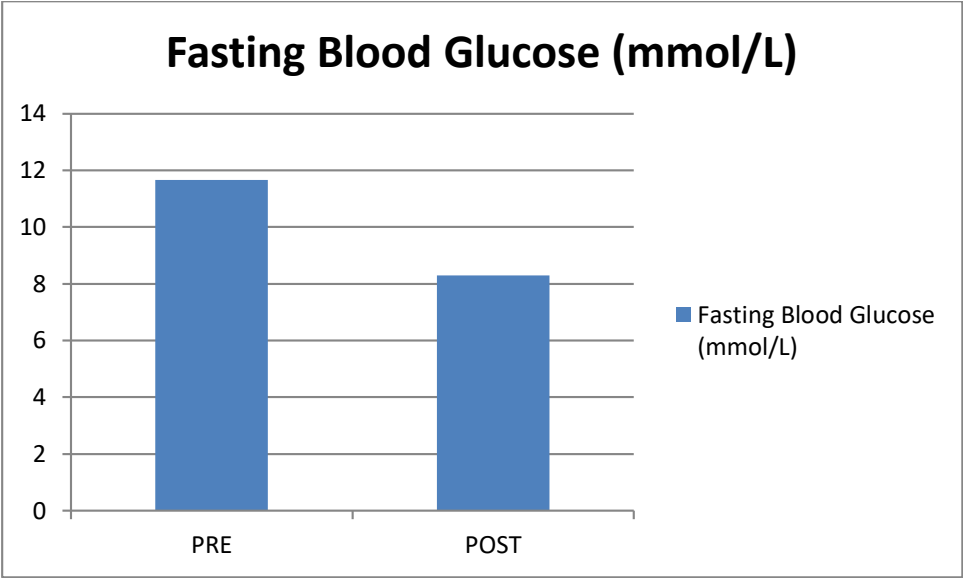
PARAMETERS	BASELINE
Age (years)	Mean = 45; Range 35 - 55
Duration since diagnosed with DM2 (years)	Mean = 7.5; Range 2 - 16

Table 7: Pre intervention and Post intervention data of participants included in the study

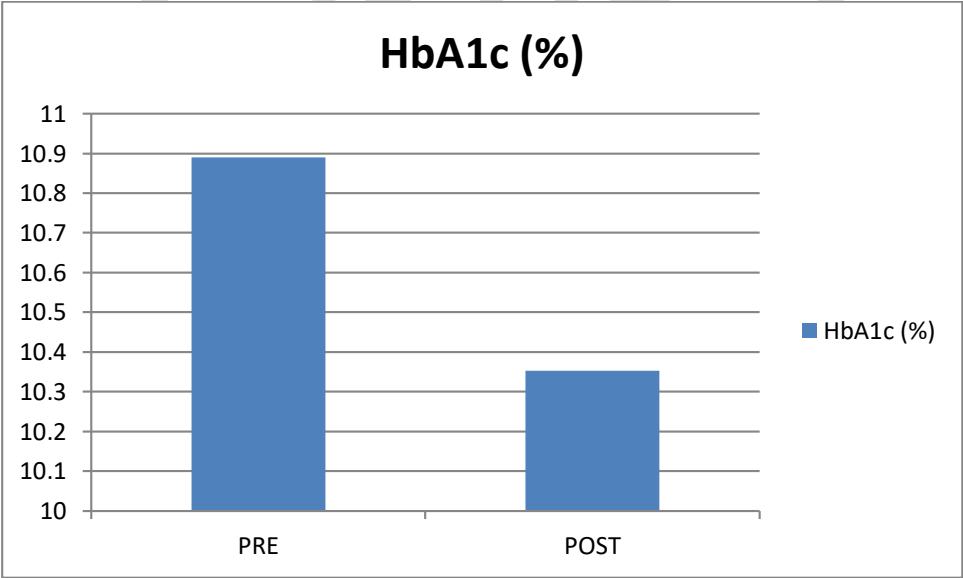
OUTCOME MEASURES	PRE	POST	P VALUE
Fasting Blood Glucose (mg/dL) Mean (SD)	210.30 (21.66)	150.07(22.41)	< 0.0001
Fasting Blood Glucose (mmol/L) Mean (SD)	11.650 (1.204)	8.290(1.249)	< 0.0001
HbA _{1c}	10.890(1.703)	10.353(1.759)	< 0.0001



Graph 1: Fasting Blood Glucose (mg/dL) for participants in the study



Graph 2: Fasting Blood Glucose (mmol/L) for participants in this study



Graph 3: HbA_{1c} (%) for participants in this study

DISCUSSION

This pre test – post test study presents findings of a novel unique structured therapeutic exercise program for individuals suffering from DM2. The current study elucidated the effect of a novel unique structured therapeutic exercise program on blood glucose levels viz fasting blood glucose (mg/dL), fasting blood glucose (mmol/L) and HbA_{1c} (%) among individuals suffering from DM2. There has been a reduction in the blood glucose levels among individuals suffering from DM2 in this study.

This reduction in blood glucose levels could be related due to an increased metabolism and increased glucose uptake in the muscles. Increase in lean muscle mass could also be attributed as a cause of the reduction in blood glucose levels due to the novel unique structured therapeutic exercise program among individuals suffering from DM2.

Similarly, Yanai H. et al in a narrative review stated that structured exercise durations of more than 150 min/ weeks were associated with HbA_{1c} reduction of 0.89%, while structured exercise duration of 150 min or less per week were associated with HbA_{1c} reduction of 0.36%. ¹¹ In our study, the novel unique structured therapeutic exercise program was performed for almost more than 150 min/ week, hence, this could have led to the reduction in the blood glucose levels in individuals suffering from DM2.

In another study by Shakil-ur-Rehman S. et al found prognostic effect of a 25 week structured supervised aerobic exercise therapy program along with routine medical management on fasting blood glucose and glycaemic control among individuals with diagnosed with DM2.¹² In our study, we had an intervention program of structured therapeutic exercise for 12 weeks which has resulted in reduction in blood glucose levels among individuals suffering from DM2. If our intervention period would have been longer, maybe the magnitude of reduction of blood glucose levels could have been greater.

Yet, in another study, Soleimani A. et al in 2023, found a very peculiar result that moderate intensity exercises among individuals suffering from DM2 yields a lowering of fasting blood glucose levels. The authors have attributed this lowering of blood glucose levels to an increase in physical activity and reduction in sedentary lifestyle among individuals suffering from DM2.¹³ Similarly, in our study too, a lowering of blood glucose levels viz Fasting Blood Glucose (mg/dL), Fasting Blood Glucose (mmol/L) and HbA_{1c} (%) mainly due to the increased physical activity achieved by performing the therapeutic exercises at moderate intensity among the participants who suffer from DM2.

CONCLUSION

Thus, we can conclude that a novel uniquely designed structured therapeutic exercises have a prognostic effect on lowering the blood glucose levels among individuals who are suffering from DM2. But, larger clinical trials are required which will be needed to generalise this research findings.

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