ORIGINAL ARTICLE

Home-Based Resistance Training Improves Glycemic Control and Body Fat Content in Patients with Type 2 Diabetes Mellitus: Experience from a Tertiary Care Hospital in Sri Lanka

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ABSTRACT

Background: Physical exercise is a key component in management of diabetes. Benefits of aerobic exercise are well established. Role of resistance training is less well studied and data from local setting are limited. We aimed to study the effect of resistance training on glycemic control and body fat. **Methods:** A randomized controlled study was conducted in a diabetes clinic, involving 60 participants with type 2 diabetes mellitus. 30 of them were randomly allocated to resistant training with Thera bands. Routine medical and dietary management were continued in both groups. Glycated hemoglobin A1c (HbA1c), fasting blood glucose (FBG), body mass index (BMI), and body fat percentage (BFP) were measured at baseline and after 4 months. **Results:** Mean age, mean duration of diabetes, baseline HbA1c, FBG, BMI, and BFP of the population were 53.6 years, 11.3 years, 8.8%, 135.0 mg/dL, 26.9 kg/m^2, and 31.3%, respectively. Resistant training group achieved significant reductions in HbA1c (10.3%, p=0.001), FBG (5.9%, p=0.01), BMI (4.1%, p=0.02), and BFP (6.1%, p=0.03), while changes in the control group were insignificant. **Conclusions:** Resistant training improves glycemic control and body weight in short term, in patients with type 2 diabetes mellitus.

Key words: Diabetes, exercise, glycemic control, resistance training

BACKGROUND

Achieving and maintaining optimal glycemic control is the primary goal in the management of diabetes. Main strategies employed to realize this goal are pharmacotherapy, dietary interventions, and physical exercise. Role of aerobic physical exercise in improving glycemic control is well established.[1] However, patients who are unable to engage in such physical activities are not uncommon among people with diabetes, particularly in the elderly. Resistance training exercise programs which can be done without bearing weight on lower limb joints become a valuable alternative in such people.

Resistance training refers to a form of active exercise in which a dynamic or static muscle contraction is maintained against external resistance. Several recent studies have recognized resistance training as a potentially useful therapeutic tool in the management of diabetes.[2-4] Importantly, it has also been demonstrated to be safe and efficacious for the elderly and obese individuals[2] and is recommended by American College of Sports Medicine to be included in an exercise program for people with diabetes.[5] Similar to aerobic exercise, resistance training has been reported to enhance insulin sensitivity, daily energy expenditure, and quality of life.[6]

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Direct impact of resistant exercise training in improving glycemic control has been evaluated in several small-scale studies around the world with promising results. However, data on this regard from local and regional settings are limited. We aimed to study the effect of resistance training on glycemic indices and body mass index (BMI) and body fat content in patients with type 2 diabetes mellitus.

MATERIALS AND METHODS

A randomized controlled study was conducted in the Diabetes Clinic, University Medical Unit, National Hospital Sri Lanka, from April to September 2013. Nearly 100 patients with diabetes are seen weekly in this clinic of whom majority are from the Colombo district. Participants were recruited by convenient sampling method and were randomly allocated into control and intervention groups by computer-generated random number system.

Individuals aged between 18 and 65 years, who have had type 2 diabetes mellitus for at least 2 years were included in the study. Those with severe cardiovascular disease, disabling arthritis, balance disorders, acute illness, and pregnant or lactating mothers were excluded from the study.

71 patients with type 2 diabetes mellitus were recruited by convenient sampling and 60 of them fulfilled the inclusion criteria to enter the study. They were randomly assigned to two groups. Regular medical and dietary management were continued in all participants while one group was trained on regular resistance training [Figure 1].

Clinical information was recorded using an interviewer-administered questionnaire. Glycated hemoglobin A1c (HbA1c) and fasting plasma glucose were measured using high-performance liquid chromatography method and POINTE 180 Biochemistry analyzer, respectively, in medical laboratory of the Department of Clinical Medicine, Faculty of Medicine Colombo.

Height and waist and hip circumferences were measured by trained personnel using standard protocols, and weight was measured using calibrated stadiometer. Body fat percentage (BFP) was estimated using bioelectrical impedance analyzer. All measurements were made at recruitment and at the completion of 4 months.

Both control and intervention groups continued to receive their standard medical treatment along with dietary and lifestyle modifications. Individuals of the intervention group were trained to engage in resistance exercises using Thera bands by the principal investigator. An exercise regimen consisted of warm up for 5 min, shoulder front rise, shoulder lateral raise, biceps curl, triceps extension, knee straightening, hummie curl, seated crunch, calf raise, and then cool down for 5 min. Each step is done in 8–10 repetitions per set and 2–3 sets per session. Complete session would take 30–40 min. Participants were expected to engage in this activity 3 days a week for 4 months. Participants were provided with verbal and diagrammatic description on each step. They were expected to maintain a log of activities and were given reminders over the phone to maintain motivation and ensure adherence.

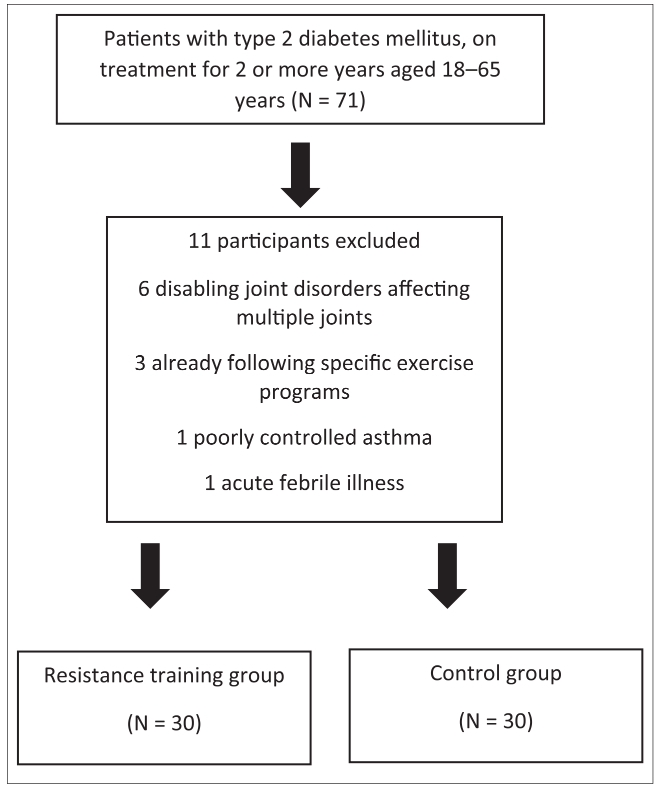

Figure 1: Pathway of recruitment, exclusion, and random allocation of participants in to resistance training and control groups

Ethical clearance was obtained from the Ethics Review Committee of Faculty of Medicine, University of Colombo. Informed written consent was obtained from all study participants.

Data were analyzed using SPSS version 17.

RESULTS

Resistant training and control groups comprised 30 participants in each. 40% of the participants were male. Mean age of the total population was 53.6 (±6.1) years while mean duration of diabetes was 11.3 (±4.4) years. Mean HbA1c, fasting blood glucose (FBG), BMI, and BFP of the study population were 8.8 (±2.1) %, 135.0 (±41.1) mg/dL, 26.9 (±2.3) kg/m^2, and 31.3 (±6.7) %, respectively. Two groups did not differ significantly in any of these characteristics [Table 1].

Participants in the resistance training group showed significant reductions in all measured parameters while changes in the control group were statistically insignificant [Table 2].

Resistant training group achieved a 10.3% relative reduction of HbA1c (from 8.7 [±1.9]% to 7.8 (±1.1)%; $P = 0.01$) while reduction in control group was only 1.1% and statistically insignificant ($P = 0.31$) [Figure 2]. Similarly, a 5.9% reduction in FBG was achieved by resistant training group ($P = 0.01$) while FBG in control group showed an insignificant increase by 2.5% ($P = 0.36$).

Beneficial effects were also observed in anthropometric parameters. While resistant training group showed significant reductions in BMI (4.1%, $P = 0.02$) and BFP (6.1%, $P = 0.03$), control group showed insignificant increases in both (0.4%, $P = 0.98$ and 6.1%, $P = 0.51$, respectively).

DISCUSSION

To the best of our knowledge, this is the first published study from Sri Lanka on the effectiveness of resistance training exercise in improving glycemic control in people with diabetes. Several small-scale studies from other regions of the world have shown significant benefit and results of our study are comparable with those.

Castaneda *et al*. in a similar study in 2002 demonstrated that high-intensity resistance training program improved HbA1c and achieved a reduction of truncal fat mass.[2] However, changes in BMI or estimated total body fat content were not reported.

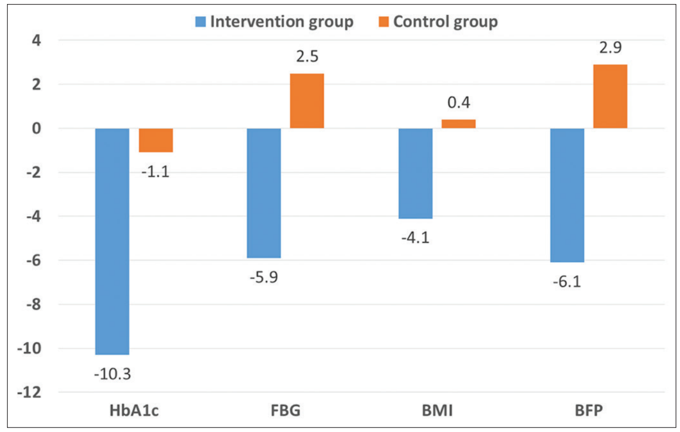

Figure 2: Percentage changes of anthropometric and glycemic parameters

Table 1: Comparison of baseline characteristics of intervention and control groups

Parameter	Intervention group	Control group	*P* value
Number	30	30	-
Mean age (SD) (years)	53.3 (6.2)	54.0 (6.0)	0.91
Male: female ratio	1.6 :1	1.4 :1	0.45
Duration of diabetes (SD) (years)	11.2 (4.5)	11.3 (4.3)	0.83
BMI (SD) (kg/m^2)	26.8 (2.3)	27.0 (2.4)	0.45
Body fat percentage (SD) (%)	31.3 (5.8)	31.3 (6.9)	0.50
HbA1c (SD) (%)	8.7 (1.9)	8.8 (2.1)	0.83
FBG (SD) (mg/dL)	132.1 (34.9)	137.9 (44.7)	0.14

BMI: Body mass index, FBG: Fasting blood glucose, HbA1c: Glycosylated hemoglobin 1c, SD: Standard deviation

Table 2: Comparison of changes in anthropometric and glycemic control parameters

Parameter	Resistance training group			Control group		
	Baseline	After 4 months	*P*	Baseline	After 4 months	*P*
HbA1c (%)	8.7 (1.9)	7.8 (1.1)	0.01	8.8 (2.1)	8.7 (2.2)	0.31
FBG (mg/dL)	132.1 (34.9)	124.4 (32.9)	0.01	137.9 (44.7)	141.4 (51.6)	0.36
BMI (kg/m^2)	26.8 (2.3)	25.7 (2.5)	0.02	27.0 (2.4)	27.1 (2.7)	0.98
BFP (%)	31.3 (5.8)	29.4 (3.2)	0.03	31.3 (6.9)	32.2 (5.1)	0.51

HbA1c: Glycosylated hemoglobin 1c, FBG: Fasting blood glucose, BMI: Body mass index, BFP: Body fat percentage, SD: Standard deviation

Dunstan *et al*. compared a weight loss only programme with a weight loss and resistance training combined programme in elderly people (age 60–80 years) with diabetes and concluded that combined regimen achieved better improvements in HbA1c compared to weight loss alone.[3] Weight loss only group had lost lean mass while the other group had gained. This further supports the relationship between lean mass and improved insulin sensitivity. However, total study population was smaller (n = 36) in this study.

Results from our study show that a significant improvement in glycemic control was achieved despite a less marked change in BMI, an observation made in several other studies as well. This is probably attributable to the fact that increases in skeletal muscle mass itself improve insulin sensitivity and therefore the glycemic control. Importantly, metabolic benefit becomes evident as early as within 4 months. Furthermore, strength training can be done in-doors, with minimum equipment, without bearing weight on lower limb joints, and therefore is possible even in those with osteoarthritis, a common problem in aging populations.

However, these results should be interpreted with caution. First, our study is limited by relatively small sample size and short duration of follow-up. This was not designed to evaluate the effect on lipid parameters and blood pressure control, other important components of metabolic syndrome, and strong predictors of cardiovascular events. Sustainability of this intervention, it's impact on long term glycemic control and morbidity and mortality will have to be studied further in long term large scale trials.

Participants in our study were trained in small groups and adherence to the regimen was assessed based on a log maintained by participants themselves. However, one-to-one individual training and a home visit-based assessment of adherence and feedback mechanism would have improved efficient practice of the exercise regimen at a higher rate of adherence.

CONCLUSIONS

Based on the results of our study, we conclude that resistance training exercise over a period of 4 months improves HbA1c in individuals with type 2 diabetes. This non-weight-bearing exercise regimen can be followed by most individuals including those with lower limb osteoarthritis, a common problem that limits mobility, particularly in the elderly.

Our study also highlights several areas for further research. A long-term study with a larger sample would provide further evidence on impact on long-term morbidity, cardiovascular outcomes, and mortality. Furthermore, studies can be designed to compare the effects of different regimens of resistance training as well as a comparison of resistance training against endurance training. Although insulin resistance is an integral component of type 2 diabetes, whether resistance training exercise would have a benefit on those with type 1 diabetes remains inadequately studied and could be an area for further research.

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