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Towards a Self-Managed Resistance Exercise Program for Overweight/Obese Individuals with Type 2 Diabetes: A Pilot Study

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ABSTRACT

Chan D, Ried K. Towards a Self-Managed Resistance Exercise Program for Overweight/Obese Individuals with Type 2 Diabetes: A Pilot Study. **JEPonline** 2013;16(3):9-19. A 16-wk semi-supervised, community-based, self-management focused, progressive resistance training using exercise bands was conducted on a single cohort of type 2 diabetic patients. The purpose of this study was to determine the program's efficacy to increase strength and physical activity level. In the 1st 8 wks, the participants consulted an exercise physiologist for exercise, physical activity, and self-management counseling 1 time·wk^{-1} while the participants performed the resistance exercises 2 times·wk^{-1} at home. During the 2nd 8 wks, telephone counseling was conducted in wks 10 and 14, in addition to one face-to-face meeting conducted in wk 12. Participants continued to exercise 3 times·wk^{-1} at home. Twenty participants (59.5 ± 12.0 yrs) were enrolled, 9 (45%) completed the 1st 8 wks, and 3 (15%) completed the 16-wk program. At 8 wks, 1 min knee push up, 1 min sit-to-stand and physical activity level estimated from the Australia Active Survey had all significantly improved (P<0.05). Two out of the 3 participants who completed the program had improved glycosylated hemoglobin. This feasibility study highlights the potential and challenges of a community-based, self-managed resistance exercise program to benefit the health of diabetic patients.

Key Words: Self-Management, Type 2 Diabetes, Physical Training

INTRODUCTION

Current evidence supports diabetic patients to adopt a balanced, healthy diet with regular and sufficient exercise to manage their blood glucose and lipids level (9). When compared to aerobic exercise, resistance exercise has been shown to be just as effective in managing diabetic patients' blood glucose level (15). The International Diabetes Institute (currently part of Baker IDI Heart and Diabetes Institute) found that regular, progressive resistance exercises among older adults with type 2 diabetes improves glycosylated hemoglobin (HbA_{1c}) level, which is an index of average blood glucose level of the past 3 months. Patients who were later allocated to continue with the supervised resistance exercise program and lifestyle counseling by qualified professionals was able to improve or maintain their blood glucose level while those in home-based exercise program reverted to their baseline values (7,8).

Although these findings support the importance of periodic professional exercise guidance to ensure patients' adherence to resistance exercise at a sufficiently beneficial level, it is still unclear how long supervision needs to be and whether strategies to promote self-management in patients can foster eventual independence to be physically active long term. In addition, recent independent reviews of the literature by the Exercise and Sport Science Australia and joint American College of Sports Medicine and the American Diabetes Association have shown that similar position statements recommending weight lost and glycemic control can be more effectively achieved by a combination of aerobic and resistance exercises (6,10). Having an exercise professional to assist with the exercise prescription provides a safety net for assisting diabetic patients in managing their condition.

Although the efficacy of using elastic bands to perform resistance training for glycaemic control among type 2 diabetic patients remains uncertain, they commonly used in rehabilitation to improve strength and they are equally effective in muscle activation compared to free weights in healthy females (2). Elastic resistance can also increase fat-free mass and decrease fat mass comparable to using weight machines, as indicated by Colado and Triplett (4) in sedentary healthy females. In contrast, Cheung et al. (3) adopted the use of elastic bands for a home based program but failed to elicit improved glycaemic control. The authors suggested that the limited provision of resistance elastic bands might have impeded any further progression over time.

Given that an increase in self-managed exercise by diabetic patients may help improve their health and reduce the cost of their condition, a 16-wk semi-supervised, community-based, self-management focused, progressive resistance training using exercise bands was conducted on a single cohort of type 2 diabetic patients. The purpose of this study was to determine the program's efficacy to increase strength and physical activity level in type 2 diabetic patients. We hypothesized that with increased physical activity level and resistance training type 2 diabetic patients would improve physical strength after 8 wks and glycemic control after 16 wks.

METHODS

Subjects

We included adults 18 yrs of age and older with: (a) type 2 diabetes for more than 6 mths; (b) last measured glycosylated hemoglobin (HbA_{1c}) between 7 and 10% (diabetes diagnosis criteria: HbA_{1c} ≥6.5%); (c) body mass index (BMI) >25; and (d) not insulin-dependent. Informed written consent was obtained from all participants. The University of Adelaide's Human Research Ethics Committee approved the study.

Procedures

Study Design and Setting

The recruitment process included an invitation to 13 general practice clinics and 4 registered diabetes educators in northern Adelaide metropolitan for patient referral, posters in diabetes units of two Adelaide hospitals, two walking groups, two churches, one community notice board, 14 pharmacies, and an advertisement in Diabetes South Australia's magazine reaching over 30,000 readers in the state. With the available funding and resources, an initial 20 participants were recruited in this single cohort, exercise intervention pilot study (Figure 1).

Feedback and Follow-Up

Invited non-responding general practice clinics were followed-up in person, by mail or phone to elucidate the reasons for the lack of response. Feedback on how to improve the program and self-perceived impact were also sought from participants and recorded by the exercise physiologist during face-to-face counseling or by phone when participants dropped out.

Intervention

An exercise manual was provided to each participant. It consisted of exercise instructions, a guide to progress in elastic resistance, a guide to setting goals and an exercise log. All sessions and equipment were provided free of charge. The participants were instructed to perform elastic resistance exercises 3 times$\cdot$wk^{-1} throughout the intervention period. During the 1st 8 wks, each participant was counseled and supervised once a week by an exercise physiologist in person to help perform the exercises correctly. Feedback and progression of exercise volume and intensity were made during the sessions as required. Participants were asked to perform the same exercises at home on 2 other non-consecutive days per week.

From the 9th to the 16th-wk, supervision ceased and participants were instructed to continue to do resistance exercises 3 times$\cdot$wk^{-1} at home. The participants met with the exercise physiologist at 12 wks for a follow-up face-to-face counseling and exercise session. The participants also received telephone counseling by the exercise physiologist at 10 and 14 wks. During counseling, the following psychosocial methods were also used accordingly: (a) assessing stage of readiness for change; (b) setting goals; (c) assessing participants' network for social support; and (d) motivational interviewing (1,11,14). These methods were used with the aim to better understand each participant, to encourage and set strategies in building exercise self-efficacy, and to reduce barriers to exercise with the aim to increase physical activities and confidence to exercise.

The resistance training was designed to work on all major muscles groups, which included 4 upper body and 2 lower body resistance exercises: standing chest press (pectoralis), standing row (back muscles), pull down (latissimus dorsi), standing shoulder press (trapezius), lunges (hamstrings), squat (quadriceps femoris), and diagonal chops (abdominal). The exercise intervention utilizes the Theraband™ tubings that were improvised to allow progressive resistance training involving both concentric and eccentric contractions. This was achieved by using carabineers to attach different combinations of different color-graded Theraband™ tubing onto foam handles. As the elastic tubings have up to 5 colors graded resistance, resistance was further progressed by connecting different colors of tubings to handles. A table was derived based on the resistance produced by Theraband™ tubings (13) when elongated by 100% of its length, which was used to guide the exercise physiologist in the resistance progression (Table 1). Each participant was given a set of the elastic tubings at the start of the intervention. In the 1st 2 wks, a resistance level was chosen that allowed the participants to perform 3 sets of 10 to 20 repetitions on Borg's rating of perceived exertion (RPE) (1) of 10-11 (fairly light). From the 3rd wk forward, each participant progressed to 3 sets of 10 to 20 repetitions on Borg's RPE of 13-16 (somewhat hard to slightly harder) by using heavier resistance.

Figure 1. Study Flow Diagram.

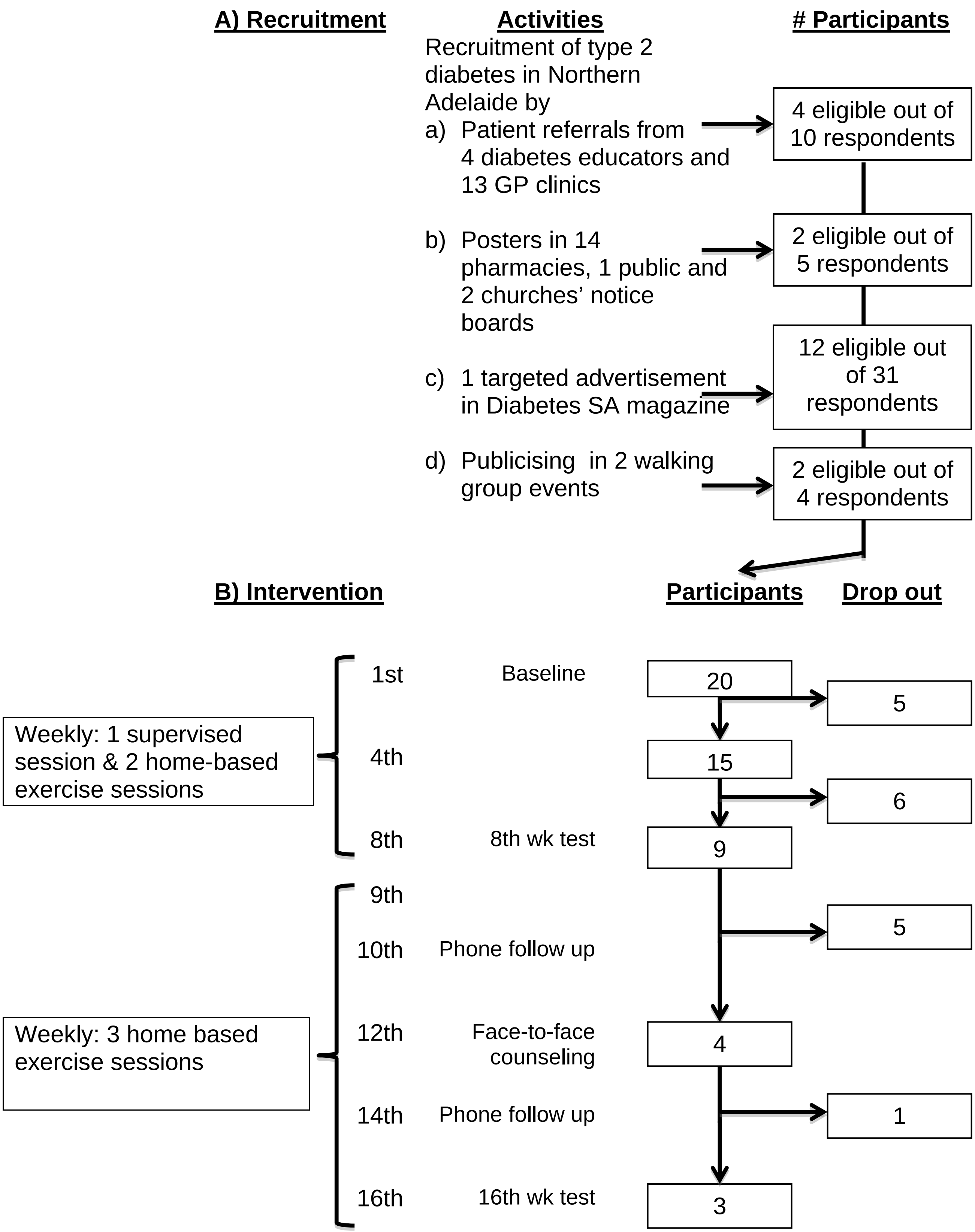


Table 1. The Coloured Elastic Tubings were Used in Different Combination According to the Colour Illustrated to increase resistance Progressively.

Grade	Sequence							Colour Combination	Total Resistance (kg)
	1st	2nd	3rd	4th	5th	6th	7th		
1								Green	2.3
2								Blue	3.2
3								Black	4.4
4								Silver	6.0
5								Green+Black	6.7
6								Blue+Black	7.6
7								Silver+Green	8.3
8								Silver+Blue	9.2
9								Silver+Black	10.4
10								Silver+Green+Blue	11.5
11								Silver+Silver	12.0
12								Silver+Black+Green	12.6
13								Silver+Black+Blue	13.6
14								Silver+Black+Black	14.8
15								Silver+Silver+Blue	15.2
16								Silver+Black+Blue+Green	15.9
17								Silver+Black+Silver	16.4
18								Silver+Black+Blue+Blue	16.8
19								Silver+Silver+Blue+Green	17.5
20								Silver+Black+Blue+Black	18.0
21								Silver+Silver+Blue+Blue	18.4
22								Silver+Black+Blue+Blue+Green	19.1
23								2Silver+Blue+2Green	19.8
24								Silver+Blue+2Black+Green	20.3
25								Silver+Silver+Black+Black	20.8
26								2 Silver+Blue+Black+Green	21.9
27								2 Silver+2Blue+2Green	23.0
28								2 Silver+2Black+1Blue	24.0
29								4 Silver+1Green	26.3
30								3 Silver+1Green+1Black	27.9
31								3 Silver+2Black+1Green	29.1
32								4 Silver+1Green+1Blue	29.5
33								3 Silver+2Black+1Blue	30.0

Outcome Measures
General medical history was documented. The following assessments were conducted at baseline, 8th-wk, and 16th-wk of the intervention: height, weight, waist and hip circumference, estimated physical activity level in the past week using the Active Australia Survey (16) and the Exercise Self-Efficacy Survey with a 5-point Likert Scale (11) from 1 (not at all confident) to 5 (extremely confident). The Exercise Self-Efficacy Survey required the participants to rate their confidence to overcome each of the following five common barriers (tiredness, bad weather, bad mood, limited time, and on vacation) to carrying out their exercise intentions.

Upper body (UB) strength endurance was determined by the 1-min knelt push up. Lower body (LB) strength was determined by the 1-min sit to stand. As part of their diabetic management in Australia, patients' glycosylated hemoglobin (HbA_{1c}) was routinely measured by their general practitioners every 3 mth. The HbA_{1c} results were obtained within 3 mth prior to participation and then at the end of the intervention. All participants were instructed to use an exercise log, which was collected when each participant ceased participation.

Statistical Analysis
Independent *t* tests were conducted on all outcome measures at baseline and at 8 wks for all remaining participants. Statistical analysis at 16 wks was not performed since only 3 participants remained in the study. All statistical analyses were performed using statistical software SPSS (version 17.0, SPSS Inc, Evanston, IL). The alpha level of $P<0.05$ was set for statistical significance.

RESULTS

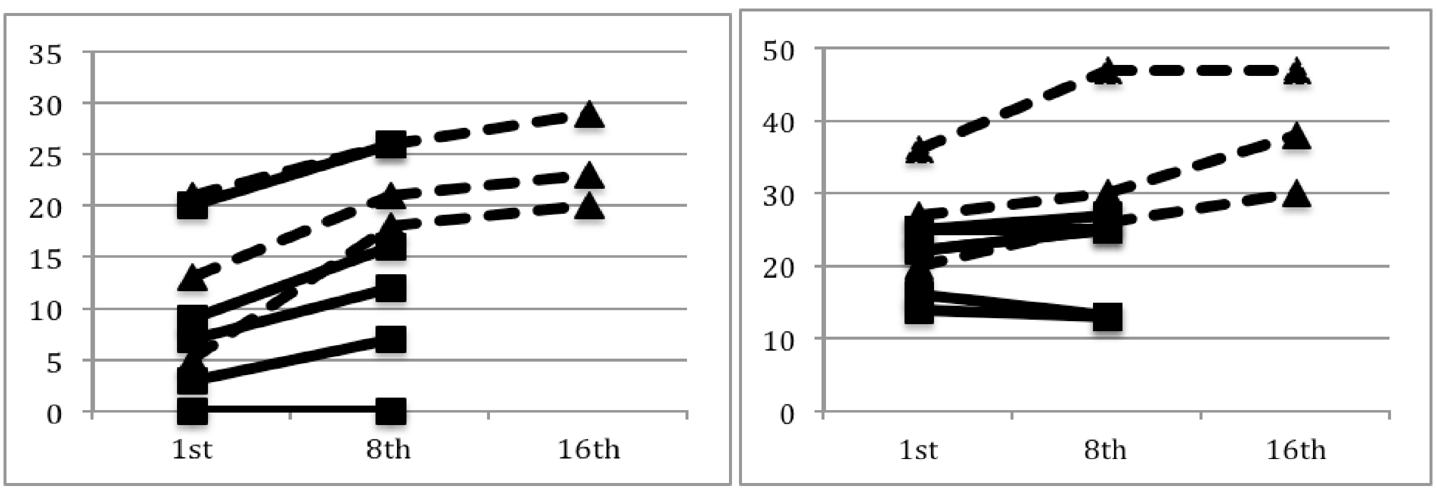
Between baseline and 8 wks, there was a significant improvement ($P<0.005$) in upper limb strength endurance (knee push up). Lower limb strength endurance did not reach statistical significance ($P<0.1$) (Table 2). Although the participants significantly increased the number of sessions and the amount of physical activity in a week, there were no significant changes in BMI, waist and hip circumferences, and exercise self-efficacy score.

Table 2. Outcome Measures of 9 Participants Who were Assessed at 8 Wks into the Program.

Variable	Baseline	8 Wks	P-value
1 Min Knee Push Up	8.7 ± 7.9	14 ± 10	0.004*
1 Min Sit to Stand	23.0 ± 6.5	25.7 ± 10	0.09
Exercise Self-Efficacy Score	19.9 ± 2.6	19.6 ± 3.1	0.74
BMI ($kg \cdot m^{-2}$)	37.0 ± 9.4	36.5 ± 8.7	0.30
Waist Circumference (mm)	1127.3 ± 181.0	1120.3 ± 169.9	0.77
Hip Circumference (mm)	1152.7 ± 195.5	1135.7 ± 187.2	0.14
Total Physical Activity Time	145.0 ± 109.0	402.2 ± 180.6	0.0002*
Total Physical Activity Sessions in a Week	4.0 ± 2.2	8.9 ± 2.8	0.001*

Twenty participants (mean age = 59.5 ± 12.0 yrs; male = 12, female = 8) were recruited. By the 8th wk, 9 participants (mean age = 63.6 ± 10.5 yrs; male = 4, female = 5) remained in the study. By the 16th wk, 3 participants (mean age = 57.7 ± 15.4 yrs; male = 2, female = 1) completed the program. Five main reasons for drop out at 16 wks were identified. There was no indication of any relationship between the period and the reason the participants dropped out (Total drop out = 17). Five (8 wks = 4, 16 wks = 1) dropped out due to an injury acquired or aggravation of earlier chronic physical injuries after the start of the program. An additional 5 participants (8 wks = 2, 16 wks = 3) withdrew due to unforeseen occurrence of medical problems not related to the program. Two (8 wks = 1, 16 wks = 1) dropped out due to injury from other activities. Two (8 wks = 2, 16 wks = 0) participants found the program difficult or boring. Three participants dropped out due to social or personal issues (Figure 1).

At the end of the 16th-wk intervention, only 3 participants completed the program and were assessed. Two of the 3 participants lost an average of 3.65 kg of body weight, thus lowering their BMI by 1.2 and 1.8, respectively. Their HbA_{1c} also decreased (7.1 to 6.8 and 8.1 to 7.4). The patient that did not lose weight had the same HbA_{1c} (8.8 to 8.7) as baseline. Physical activity level per week significantly increased from an estimated 640 min to 1345 min at 8 wks and 1165 min at 16 wks. There was also a trend for improvement in upper and lower limbs strength endurance for the 3 participants (Figure 2). Exercise self-efficacy scores tended to be lower at 8 wks compared with baseline in those who only completed the 8-wk course of exercises, while there was an increasing trend at 8 and 16 wks of those patients who completed the 16-wk the program (Figure 3).



2(a) 2(b)

Figure 2. Number of (2a) knee push up and (2b) sit to stand each participant completed in 1 min on the 1st, 8th, and 16th-wk in those who completed 8 wks (solid line + squares) and 16 wks (dotted line + triangles) of exercise.

When feedback was sought for general practitioners' lack of response, none replied except one general practice clinic owner relaying to her practice manager that once a week of exercise is too much of a commitment for diabetic patients. The patients provided informal feedback that they would rather have had more sessions at the early stage to better adjust to the exercise equipment so that they could perform the exercises correctly.

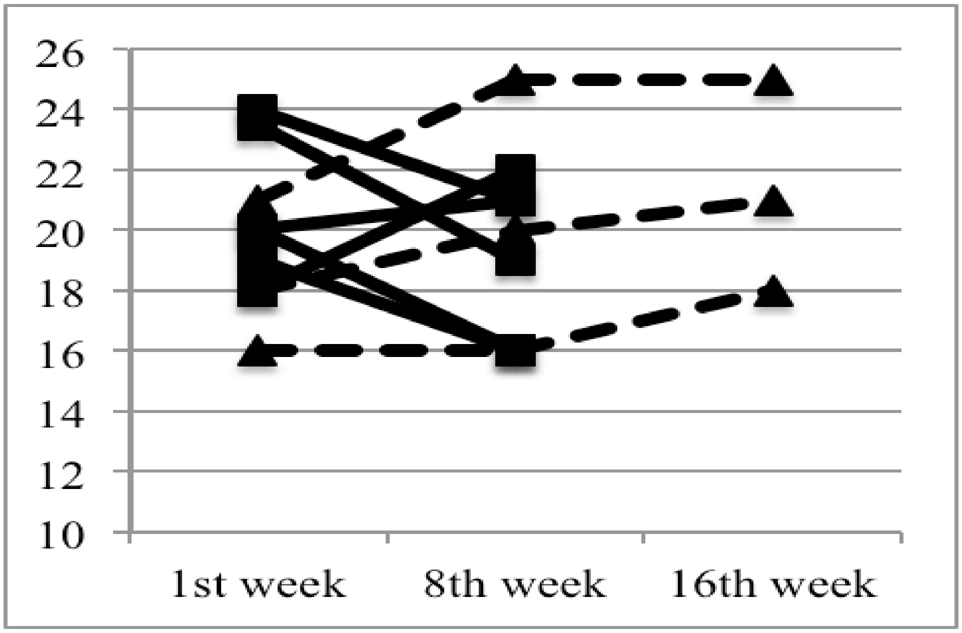


Figure 3. Exercise self-efficacy score of each participant who completed 8 wks (solid line) and 16 wks (dotted line) of exercise.

DISCUSSION

Although the pilot study indicates that a semi-supervised, community-based, self-management focused, progressive resistance training using elastic tubing's can improve strength endurance and increase the frequency and amount of physical activity level in type 2 diabetic participants in 8 wks, the challenge is to keep the participants from dropping out. Further strength endurance improvement was also evident in the 3 participants who completed the 16-wk exercise program. Only two out of the remaining 9 participants lost weight at 8 wks and also had clinically significant improvement in HbA_{1c} at the end of the program. These findings suggest that if type 2 diabetic patients were to participate in a moderate to high intensity level resistance exercise program (using elastic tubings) for at least 8 wks, the resulting improvement in physical strength and glycemic management is as effective as the International Diabetes Institute's supervised exercise program that used free weights and weight machines (7).

Compliance and Dropout

Interestingly, the high dropout rate at 8 wks (55%) and 16 wks (85%) in addition to the 4 (20%) participants who indicated that the program resulted in an injury or made an existing injury worse suggest that it may not be suitable for all diabetic patients. Often, many diabetic patients must deal with physical, psychosocial, and medical issues that require changing their lifestyle or adopting regular exercise habits. This is reflected in the patients' reasons for dropping out. A review conducted by Norris et al. (12) of 72 self-management training trials for type 2 diabetic patients showed that despite improved patient knowledge and self-care skills reported in 33 out of 46 studies, improved glycemic control in diabetic patients was indicated in only 18 of the 54 studies. This suggests that providing patients with technical information is not sufficient for self-management. Although the purpose of the present study was to modify the participants' behavior by setting exercise goals and developing strategies to reduce barriers to exercise, there are others areas of the participants' lives that distract from a regular exercise program.

Referrals by General Practitioners

Whether a multi-disciplinary team of healthcare professionals can improve exercise compliance in type 2 diabetic patients is unknown. It is unfortunate that out of the 13 general practice clinics each with at least three general practitioners, only two general practitioners responded to our invitation to refer patients to our exercise program. The reason for general practitioners' reluctance to refer their patients to the program is speculative since only one general practitioner gave feedback. More research needs to be conducted in the primary care setting on exercise self-management counseling in type 2 diabetes and, equally important, the perceptions and attitudes of general practitioners in referring chronic disease patients to exercise physiologists for exercise counseling and supervision.

The present study also compared its findings to a similar government-funded supervised resistance exercise program study, specifically, the Life For Life Program of the Baker IDI Heart and Diabetes Institute (7). Follow up of 25 Lift For Life Program providers in South Australia found that many had received few to no referral, and had ceased running the program. The providers did not know the reason for the lack of referral. However, it is important to point out that the providers employed personal trainers instead of exercise physiologists to run the program.

Exercise Counseling

One of the aims of this study was to test whether once a week face-to-face exercise counseling and supervision by an exercise physiologist, and the use of home-based exercise equipment would be sufficient to improve the participants' exercise habits. But, unfortunately, the 55% dropout rate of the participants during the 1st 8 wks seems to indicate the contrary. But, with an estimated 2-fold increase in physical activity level by 8 wks, it appears that the counseling was effective. However, the participants' feedback indicated that more supervision of the exercise sessions at the initial stage is necessary to increase their confidence in performing the resistance exercises at home.

Current exercise guidelines (5) for type 2 diabetic patients indicate that to optimally manage glycemic control and produce weight loss states that both aerobic exercise and moderate to high intensity resistance exercises 2 to 3 times$\cdot$wk^{-1} are necessary. Hence, it was important that the exercise physiologist in the present study encouraged the participants to increase their physical activity level while also engaging in the resistance exercise program. The high dropout rate in the present study is an excellent indication of the difficulty that type 2 diabetic patients experience when encouraged to exercise. Any general practitioner or exercise physiologist who counsels type 2 diabetic patients needs to take note that the ideal exercise involvement may not be attainable or preferred by many patients, especially during the initial stage of an exercise program. Hence, it is important to consider every opportunity to motivate the patient to encourage consistency and progression in the exercise regimen.

CONCLUSIONS

The aim of this study was to determine whether self-management counseling and coaching of type 2 diabetic patients in the use of elastic bands at home elicits similar benefits to a regular supervised, gym-based resistance exercise program. Unfortunately, due to the small sample size (even with some improvement), no conclusive outcome on its efficacy is appropriate. Although resistance exercise has been shown to be beneficial in managing diabetic patients' glycemic control and improving physical function and health, resistance exercise may not be easily adopted by patients without regular supervision by an exercise physiologist. In addition, the frequency of supervised exercise sessions during the initial stage may need to be greater than once per week (and longer than 8 wks) to improve the efficacy of any similar semi-supervised exercise program. The exercise physiologist should spend more time coaching patients at the onset to help ensure that they are confident and ready to perform the exercises properly and progressively. Future research should also investigate whether the involvement of other allied health professionals (e.g., dietician, psychologist, and general practitioner) would improve the patients' outcome in a similar exercise program.

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