Community Center–Based Resistance Training for the Maintenance of Glycemic Control in Adults With Type 2 Diabetes

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OBJECTIVE — The purpose of this study was to determine whether beneficial effects on glycemic control of an initial laboratory-supervised resistance training program could be sustained through a community center–based maintenance program.

RESEARCH DESIGN AND METHODS — We studied 57 overweight (BMI $\geq$27 kg/m^2) sedentary men and women aged 40–80 years with established (>6 months) type 2 diabetes. Initially, all participants attended a twice-weekly 2-month supervised resistance training program conducted in the exercise laboratory. Thereafter, participants undertook a resistance training maintenance program (2 times/week) for 12 months and were randomly assigned to carry this out either in a community fitness and recreation center (center) or in their domestic environment (home). Glycemic control (HbA_{1c} [A1C]) was assessed at 0, 2, and 14 months.

RESULTS — Pooling data from the two groups for the 2-month supervised resistance training program showed that compared with baseline, mean A1C fell by −0.4% [95% CI −0.6 to −0.2]. Within-group comparisons showed that A1C remained lower than baseline values at 14 months in the center group (−0.4% [−0.7 to −0.03]) but not in the home group (−0.1% [−0.4 to 0.3]). However, no between-group differences were observed at each time point. Changes in A1C during the maintenance period were positively associated with exercise adherence in the center group only.

CONCLUSIONS — Center-based but not home-based resistance training was associated with the maintenance of modestly improved glycemic control from baseline, which was proportional to program adherence. Our findings emphasize the need to develop and test behavioral methods to promote healthy lifestyles including increased physical activity in adults with type 2 diabetes.

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Controlled trials have demonstrated that supervised resistance training may be a viable and effective exercise modality for the improvement of glycemic control in middle-aged and older adults with type 2 diabetes (1–3). These studies have typically elucidated the efficacy of resistance training using supervised exercise sessions in well-controlled laboratory, clinic, or gymnasium settings. An advantage of this approach is that exercise prescription can be carefully monitored to encourage both appropriate adherence and exercise progression to stimulate metabolic changes. However, from a public health perspective, the effectiveness of maintenance programs undertaken in the community setting needs to be evaluated. Although maintenance programs undertaken in the home can provide convenience and flexibility (4), we have recently reported that home training for 6 months was not effective for maintaining the improvements in glycemic control associated with 6 months of supervised training in older persons with type 2 diabetes (5). The apparent ineffectiveness of home-based training was most likely due to reduced adherence and decreased exercise training volume and intensity because the workloads experienced in the supervised setting could not be replicated with the hand and leg weights used in the home.

Training programs in community facilities such as health and fitness centers or gymnasiums offer greater access to resistance exercise equipment, supervision, and group interaction than does home-based training. Such training attributes reflect several of the key social and environmental factors that can beneficially influence the maintenance of physical activity behaviors (6,7). However, there is no evidence to date to determine whether such "center-based" resistance training in people with type 2 diabetes is effective for maintaining the improved glycemic control that has typically followed laboratory-supervised resistance training interventions.

In adults with type 2 diabetes who had completed an initial 2-month period of laboratory-supervised resistance training, we compared the outcomes of a community center–based long-term maintenance enhancement intervention designed to maximize environmental and social supports along with individual self-regulation with those of a control condition with reliance primarily upon individual self-regulatory capacities (home-based training). More specifically, we aimed to determine whether beneficial effects of the initial laboratory-supervised resistance training on glycemic control, body composition, and muscle strength could be sustained through the community center–based maintenance program. The associations of adherence to the resistance-training maintenance program with changes in glycemic control were also examined.

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Abbreviations: HOMA, homeostasis model assessment; LBM, lean body mass; 1-RM, one-repetition maximum strength.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.
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RESEARCH DESIGN AND METHODS

— Men and women, aged between 40 and 75 years with (diet- and/or medication-controlled) type 2 diabetes were recruited from the clinics of the International Diabetes Institute and by a local media campaign. The inclusion criteria were overweight (BMI >27 kg/m^2 and ≤40 kg/m^2), sedentary (no strength training and <150 min brisk walking/moderate exercise per week) in the preceding 6 months, established (>6 months) but not optimally controlled type 2 diabetes (A1C range 7–10%), no treatment with insulin, and nonsmoking. Those with a medical condition listed in the American College of Sports Medicine absolute exercise contraindications (8) were excluded. After initial telephone screening, 226 potential volunteers were invited to a group information seminar about the study, with 206 further invited to attend a screening visit involving a medical history questionnaire, a resting 12-lead electrocardiogram, resting blood pressure, and A1C measurement. Of these, 61 met the full entry criteria and 60 (33 men and 27 women) agreed to participate in the study. Reasons for exclusion included history or physical findings suggestive of ischemic heart disease, systemic diseases, uncontrolled hypertension, and advanced diabetic neuropathy or retinopathy. Antidiabetes medications were continued during the study. The study was approved by the International Diabetes Institute Ethics Committee, and written consent was obtained from all participants.

The study was a 14-month randomized, controlled clinical trial and consisted of two phases. First, all participants took part in a laboratory-supervised resistance exercise training program for 2 months at the Institute's exercise laboratory (introductory phase). This was followed by a 12-month maintenance program during which participants were randomly divided into two groups: center-based (center) or home-based (home) resistance training. Throughout the maintenance phase, participants attended a healthy lifestyle information session held monthly at the Institute. These 2-h informative and interactive sessions were conducted in small groups (<10) and were designed to increase knowledge relating to physical activity participation, nutrition, and behavioral change. Handouts of the key concepts were provided. Participants were assessed before (baseline) and after the laboratory-supervised program (2 months) and after the maintenance program (14 months).

Introductory phase

All participants attended the exercise laboratory on 2 days of the week for the first 2 months. Sessions followed the format described previously (1), consisting of a 5-min warm up and a 5-min cool down period of low-intensity stationary cycling plus stretching exercises and ~45 min of high-intensity resistance training. During the 1st week of training, the resistance was set at 50–60% of each individual's one-repetition maximum strength (1-RM). Thereafter, the goal was to achieve between 75 and 85% of the current 1-RM. Three sets of eight repetitions were performed for all exercises at each training session. All sessions were supervised to ensure correct technique and to monitor the appropriate amount of exercise and rest intervals. Training workload was increased regularly as tolerated for each muscle group, after participants had successfully achieved three sets of eight repetitions with appropriate technique.

Maintenance phase

Thereafter, participants took part in a 12-month maintenance resistance training program in either the center- or home-based setting. Those in the center group received a 12-month membership to attend a specific YMCA gymnasium approved by the International Diabetes Institute. An initial orientation session at the gymnasium was provided to introduce them to the staff and training facilities. They were instructed to attend two to three exercise sessions per week on weekdays between 8:00 AM and midday during which YMCA staff members were available to assist. Participants completed a similar program of eight exercises of the major muscle groups and were instructed to increase the weight lifted once they could successfully perform three sets of eight repetitions. Initially, arrangements were made to form small "buddy groups" between participants to encourage them to exercise with other participants in the study on a regular basis. However, we discarded this approach early in the maintenance phase because we found that for several reasons, participants were unable to stay in the nominated buddy group. The most common reasons were difficulty in carrying out the role of "buddy group leader" and convening the group and difficulties in exercising at the nominated time for the group on a consistent basis. A research staff member visited the YMCA gymnasium monthly to monitor progress.

The home-based training program was similar to that described previously (5), with the exception that participants were given only one dumbbell with weight plates corresponding to the maximum amount of weight they had been using during the laboratory-supervised program. No ankle weights were provided. They were provided with a standardized upper body resistance training program involving eight upper and lower body exercises. They were instructed to complete the program in the home setting two to three times per week and to increase the weight lifted using the plates provided once they could complete three sets of eight repetitions. Additional weights were provided only if requested. This occurred for 11 participants during the 12-month period.

All participants were telephoned monthly to monitor adherence, to assist with any problems encountered with the program, and to provide advice relating to the exercise prescription. On each occasion they were asked "Have you been doing resistance training twice per week over the last month?" This information was used to assist with the calculation of a score on adherence to exercise during the maintenance period.

Testing procedures

Blood samples were obtained after an overnight fast at baseline and at 2 and 14 months for the determination of plasma glucose, serum insulin, and A1C. All samples were collected at least 48 h after exercise. Serum samples for insulin were stored at −80°C until assayed. A1C was assessed using the cation-exchange high-pressure liquid chromatography method. Plasma glucose levels were measured enzymatically (glucose oxidase) within 12 h of collection using an Olympus AU2700 automated analyzer (Olympus, Tokyo, Japan). Serum insulin was measured using a human insulin-specific radioimmunoassay kit (Linco Research, St. Charles, MO). Homeostasis model assessment (HOMA) was used to estimate insulin sensitivity from fasting insulin and glucose concentrations (9,10).

Height (centimeters) was measured using a Holtain stadiometer (Holtain, Crosswell, Wales). Body weight (kilograms) was assessed using Tannita electronic scales to the nearest 0.1 kg. Waist circumference was measured using a nonelastic measuring tape at the midpoint be-

Table 1—*Descriptive characteristics of the center-based resistance training and home-based resistance training groups at baseline (0 months)*

	Center	Home
Men/women	14/14	16/13
Age (years)	60.5 ± 8.2	62.4 ± 8.3
Duration of diabetes (years)	7.0 ± 4.1	8.3 ± 7.1
Number of people treated with		
Diet only	2	3
Single oral agent	17	8
Two or more oral agents	9	18
Serum glucose and insulin		
Fasting glucose (mmol/l)	9.0 ± 2.0	8.4 ± 1.9
Fasting insulin (pmol/l)	143.7 ± 66.1	126.6 ± 55.1
HOMA of insulin sensitivity	46.9 ± 26.1	50.7 ± 24.6
A1C (%)	7.8 ± 0.9	7.5 ± 0.5
Anthropometry		
Weight (kg)	92.6 ± 17.1	91.2 ± 13.6
BMI (kg/m^2)	32.8 ± 4.8	32.4 ± 4.4
Waist circumference (cm)	105.6 ± 11.7	107.4 ± 10.8
Body composition		
Fat mass (kg)	37.6 ± 12.3	35.8 ± 10.0
LBM (kg)	55.0 ± 9.8	55.4 ± 10.5
Blood pressure		
Systolic (mmHg)	131 ± 18.3	130 ± 16.9
Diastolic (mmHg)	69 ± 9.7	70 ± 10.4
Muscle strength (kg)		
Upper body (kg)	78.8 ± 43.9	78.3 ± 49.1
Lower body (kg)	29.9 ± 10.1	30.3 ± 12.0

Data are *n* or means ± SD. There were no differences between the groups.

tween the lower border of the ribcage and the iliac crest. Fat mass and lean body mass (LBM) were measured by bioimpedance using the BF-906 Body Fat Analyzer (Maltron International, Essex, U.K.).

Muscle strength was assessed using the 1-RM test, whereby the workload was increased incrementally until only one repetition with correct technique could be completed. The 1-RM test on the bench press and leg extension exercises was used to document the respective changes in upper body and lower body strength.

All participants maintained a resistance training log book during both intervention phases and recorded the number of prescribed exercise sessions completed. Adherence was defined as the number of exercise sessions completed divided by the total number of sessions prescribed (two times per week). Attendance during the laboratory-supervised resistance training was determined through the exercise supervisor's records, whereas during the maintenance phase, attendance was calculated from the resistance training log book or, if the book was not submitted, was ascertained from the monthly phone calls during which each subject was asked to self-report their exercise attendance in the previous month.

Statistical analyses

Statistical analysis was conducted using Stata, release 8.0 (11). Paired *t* tests were used for comparisons between baseline and 2 months (introductory phase). Analyses of all outcome variables during the maintenance phase were conducted by intention to treat, with participants analyzed according to the initial randomized assignments. Missing data were replaced with the most recent measurement. Net between-group differences were calculated by subtracting the within-group changes from baseline for the center group from the within-group changes for the home group for each time point (2 and 14 months). Time, group, and interaction effects were examined using pooled time series regression analysis for longitudinal data with random effects models. Fasting plasma insulin levels and HOMA values were log transformed to yield a normal distribution before parametric analysis. All other data were close to normally distributed. Multiple regression analysis, adjusted for age, sex, duration of diabetes, and A1C measurement at 2 months, was used to assess differences according to adherence during the maintenance phase.

RESULTS

— Three participants withdrew during the first 2 months (before randomization) and were not included in the analyses. Two moved their residence and one incurred an adverse event during the second exercise session of the program involving a hypoglycemic episode that required medical attention. On the basis of medical advice, this person subsequently withdrew from the study. There were no differences in the baseline characteristics of the participants in the center or home groups (Table 1).

Introductory phase

During the 2-month laboratory-supervised program, five participants decreased their oral hypoglycemic medication, and three had their medication increased. Mean ± SD adherence to the exercise sessions during the laboratory-based phase for all participants (n = 57) was 87 ± 15%. Analysis of pooled data showed that the 2-month laboratory-supervised program significantly reduced A1C (−0.4% [95% CI −0.6 to −0.2]), increased LBM (0.7 kg [0.2–1.3]), and increased both upper body (11.9 kg [6.5–17.2]) and lower body (4.0 kg [2.0–6.1]) strength.

Maintenance phase

Twenty-eight participants were randomly assigned to center-based training, and 29 to home-based training. Of these, one from the center group and three from the Home group withdrew from the study during the maintenance phase, but were included in the intention-to-treat analysis for all participants who were randomly assigned. Reasons for withdrawal included overseas travel, relocation for work, and illnesses unrelated to the study. During the maintenance phase, two participants from each group decreased their oral hypoglycemic medication, whereas nine participants (six center and three home) increased their medication. Insulin treatment was started in two participants from the home group during this phase.

Changes in metabolic variables

The change in A1C from baseline for both groups is shown in Table 2. The center group showed a significant reduction in A1C at both 2 and 14 months. No signif-

Table 2—*Fasting glucose, insulin, insulin sensitivity, A1C, anthropometry, body composition, and muscle strength at baseline (0 months), 2 months, and 14 months in the center and home groups and the net difference between groups*

	Within-group change			Adjusted net difference between center and home	
	0–2 months	0–14 months	2–14 months	0–14 months	2–14 months
Fasting plasma glucose (mmol/l)					
Home	−0.2 ± 2.2	−0.4 ± 2.2	−0.2 ± 2.2		
Center	−0.5 ± 1.8	−0.8 ± 1.8†	−0.3 ± 1.8	−0.4 (−1.1 to 0.3)	−0.2 (−1.2 to 0.9)
Fasting serum insulin (pmol/l)*					
Home	4.8 ± 32.8	−3.7 ± 32.8	−8.5 ± 32.8		
Center	−0.3 ± 47.6	−22.2 ± 47.6†	−21.9 ± 47.6†	−18.5 (−39.7 to 2.6)	−13.4 (−35.6 to 8.9)
Insulin sensitivity (HOMA) (%)*					
Home	−2.6 ± 12.4	−0.2 ± 12.4	2.4 ± 12.4		
Center	−4.0 ± 16.4	5.4 ± 16.4†	9.4 ± 16.4†	5.6 (−2.0 to 13.2)	7.1 (−0.5 to 14.6)
A1C (%)					
Home	−0.3 ± 1.1	−0.1 ± 1.1	0.2 ± 1.2		
Center	−0.5 ± 1.0†	−0.4 ± 1.0†	0.1 ± 1.0	−0.3 (−0.8 to 0.2)	−0.2 (−0.7 to 0.4)
Weight (kg)					
Home	0.4 ± 3.2	−1.8 ± 3.2†	−2.2 ± 3.2†		
Center	0.1 ± 4.2	−2.0 ± 4.2†	−2.1 ± 3.4†	−0.2 (−2.2 to 1.8)	0.0 (−1.9 to 2.0)
Waist circumference (cm)					
Home	−0.6 ± 5.9	−2.6 ± 5.9†	−2.0 ± 5.9		
Center	−1.7 ± 5.3	−2.9 ± 5.3†	−1.3 ± 5.3	−0.4 (−3.3 to 2.6)	0.7 (−2.3 to 3.7)
Fat mass (kg)					
Home	−0.1 ± 3.2	−1.1 ± 3.2	−1.0 ± 3.2		
Center	−0.9 ± 3.2	−1.8 ± 3.2†	−0.8 ± 3.2	−0.7 (−2.4 to 0.9)	0.2 (−1.5 to 1.8)
LBM (kg)					
Home	0.4 ± 2.2	−0.5 ± 2.2	−0.9 ± 2.2†		
Center	1.0 ± 1.6†	−0.3 ± 1.6	−1.3 ± 1.6†	0.2 (−0.8 to 1.3)	−0.3 (−1.4 to 0.7)
Upper body muscle strength (kg)					
Home	11.8 ± 17.8†	8.4 ± 17.8†	−3.4 ± 17.8		
Center	11.9 ± 19.6†	8.2 ± 19.6†	−3.7 ± 19.6	−0.2 (−9.4 to 9.0)	−0.3 (−9.5 to 8.7)
Lower body muscle strength (kg)					
Home	4.1 ± 10.5†	−3.1 ± 10.5	−7.2 ± 10.5†		
Center	4.0 ± 6.3†	3.6 ± 6.3†	−0.3 ± 6.3	6.7 (2.2 to 11.3)†	6.9 (2.3 to 11.4)‡

Data are means ± SD or means (95% CI). The respective net differences refer to the within-group change from baseline to 14 months and the within-group change from 2 to 14 months in the center group minus the within-group change from baseline to 14 months and the change from 2 to 14 months in the home group, adjusted for age, sex, and duration of diabetes. *Data were log transformed for statistical analysis. †$P < 0.05$, within-group difference; ‡$P < 0.05$, between-group difference. There were no significant differences between the groups at 2 months.

icant changes were observed in A1C for the home group. Fasting plasma glucose and insulin levels were unchanged in the home group but were significantly decreased at 14 months in the center group. There was a significant increase in insulin sensitivity (HOMA) at 14 months in the center group, but no detectable changes were observed in the home group at any time point. However, there were no between-group differences in the net change (adjusted for age, sex, and duration of diabetes) from baseline for fasting glucose and A1C at any time. The adjusted between-group differences at 14 months approached statistical significance for insulin ($P = 0.08$) and insulin sensitivity ($P = 0.09$). These results remained unchanged after adjustment for alteration in medication (increase/decrease versus no change) during the 14 months.

Changes in anthropometrics, body composition, and muscle strength

In both groups there were significant reductions in body weight and waist circumference after 14 months, whereas a significant reduction in fat mass was observed in the center group only (Table 2). LBM increased in both groups at 2 months but decreased significantly during the maintenance period (2–14 months). Upper body strength was increased in both groups at both 2 and 14 months. Lower body strength was also increased at 2 months in both groups but remained statistically significant at 14 months only in the center group. With the exception of lower body strength, there were no between-group differences for the net change between 0 and 14 months and 2 and 14 months for any of the other outcome variables (Table 2).

Adherence

The mean ± SD adherences to the exercise prescription during the maintenance phase were 68.1 ± 25.0 and 67.1 ± 27.1% in the center and home groups, respectively. Adherence during the maintenance phase was associated with a significant reduction in A1C in the center group (−0.02 [95% CI −0.03 to −0.01]) but not in the home group (0.01 [−0.01 to 0.03]), which resulted in a significant group-by-adherence interaction ($P = 0.01$), adjusted for age, sex, duration of diabetes, and A1C measurement at 2 months. The influence of adherence in the center group was further revealed by comparing the change in A1C during the maintenance phase in those in the highest tertile ($n = 9$) of adherence (75–100%) with that in the lowest tertile ($n = 9$) (0–59%). Those who attended the exercise sessions more frequently reduced their A1C more than those who attended less frequently (−0.5 ± 0.8 vs. 0.5 ± 1.1%, P = 0.02).

CONCLUSIONS — Center-based resistance training after an initial laboratory-supervised program was well tolerated by adults with type 2 diabetes and was effective for maintaining modestly improved glycemic control and insulin sensitivity from baseline levels. In contrast, although home-based training was also well tolerated, it was not effective for maintaining improved glycemic control and insulin sensitivity from baseline. However, neither center-based nor home-based maintenance training programs resulted in further improvement in glycemic control after supervised training.

Previous investigations involving resistance training in adults with type 2 diabetes in supervised settings have demonstrated reductions in A1C from baseline levels ranging from 0.5 to 1.2% (1,2,12,13). In the present study, A1C levels were 0.4% lower than baseline levels after 14 months in the center-based group. From a clinical perspective, this represents a small change. However, in the long-term, regular resistance training in the center-based setting, which prevented a further deterioration in glycemic control, may offer more advantage than home-based training, which was not sufficient for maintaining improved glycemic control, a finding consistent with our previous investigation after 6 months of supervised training (5).

Notwithstanding the differences in the mechanisms of recording adherence during the introductory and maintenance phases, our observations may reflect the results of previous studies (6,7), which have noted that adherence to exercise is often difficult to maintain outside a formal class or group. This finding underscores the challenges experienced by clinical and health professionals to motivate patients to initiate and maintain a regular exercise pattern. The importance of achieving good adherence to exercise is highlighted by the positive association between adherence and change in A1C during the maintenance phase in those assigned to center-based training. Our findings further reinforce the need to develop and test behavioral methods to enhance longer term exercise adherence after initial supervised training programs (14).

Despite almost identical levels of adherence to exercise, home training could not maintain the gains in lower body strength achieved during the laboratory-supervised program. This could be due to differences in the equipment provided to the two groups. Participants assigned to the center-based training had access to machines that were similar to those used in the laboratory-supervised program. Home training was undertaken using only one dumbbell, and, therefore, it was not possible to replicate the leg-specific exercises that were used during the laboratory-supervised program. Previously, we have reported that home training was sufficient for maintaining lower body strength after supervised training in older adults with type 2 diabetes. However, in contrast with the present study, participants were provided with ankle weights, which permitted leg-specific exercises (5). Because the lower limbs constitute a large area of muscle mass, the emphasis on a whole-body exercise program in the center-based group may have been a contributing factor to its enhanced effectiveness in maintaining improved glycemic control and insulin sensitivity compared with the home training. Thus, the type of exercise program and the equipment used in the center-based group may explain a substantial part of the difference in observed lower body muscle strength in favor of the center-based training.

We evaluated a specific maintenance approach in the community setting that was designed to maximize environmental and social supports, in addition to individual self-regulation for the resistance training. This approach is likely to be more representative of the general community setting than studies conducted in the ideal conditions of the laboratory setting. However, we observed that the provision of designated exercise sessions whereby a staff member from the center was on duty was not as successful as anticipated because center staff were also responsible for other users of the gym, and consequently, participants often exercised outside the designated times. Furthermore, the use of buddy groups did not prove to be feasible. Given that the greatest improvements in glycemic control after resistance training have come from studies in which rigorously supervised exercise sessions in small-group settings were used (1–3), the challenge remains for health professionals working in community health and fitness settings to best replicate these types of approaches in their facilities. Such endeavors should be directed to establishing cost-effective approaches emphasizing close supervision of training techniques and monitoring of the key aspects of resistance training that have been shown to be effective for improving glycemic control in people with type 2 diabetes (1–3).

Although the present study did not include comparisons with a sedentary control group, we have previously shown (5) that in older adults with type 2 diabetes, A1C levels were unchanged from baseline after 12 months in those assigned to a control exercise program involving flexibility exercise. This study is an extension of our earlier work, comparing a purposefully developed maintenance enhancement intervention in the center-based setting with a control condition involving home-based training. This study design, whereby both groups participated in resistance training, was considered necessary to maintain subject retention over a prolonged period. Although the design may have compromised the ability to detect between-group differences in the outcome variables, generally the center group experienced greater improvement in measures of glycemic control and insulin sensitivity than the home-based group. Alterations in medication dosage during the intervention may have also altered the ability to detect changes in glycemic control produced by exercise; however, changes in medication, as reflected by self-report of the addition or removal of medication, were similar between the groups, and the results were not changed after adjustment for medication changes. Together with our previous findings showing that 6 months of home-based training were not sufficient to maintain the improved glycemic control after supervised training (5), the results suggest that in the community setting, center-based training may be slightly more advantageous for the maintenance of glycemic control in adults with type 2 diabetes. Additional work will be necessary to assess the appropriateness of such programs for people with type 2 diabetes who also have ischemic heart disease or the presence of advanced complications such as neuropathy and retinopathy.

In summary, we have demonstrated that a 12-month center-based maintenance-enhancement resistance training program after an initial 2-month laboratory-supervised resistance training program proved feasible and moderately effective in sedentary adults with type 2 diabetes, resulting in improved glycemic control and insulin sensitivity compared with baseline levels. In contrast, home-based training did not result in changes in glycemic control or insulin sensitivity from baseline levels. However, with the exception of the change in lower body muscle strength, no between-group differences were observed during the maintenance period. Our finding that adherence to exercise during the maintenance period was positively associated with improved glycemic control in the center-based group suggests that more research is needed to determine the effectiveness of other behavioral strategies for optimizing exercise adherence in the community setting.

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