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Effects of 8 Weeks of Flexibility and Resistance Training in Older Adults With Type 2 Diabetes

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Flexibility is often downplayed as unimportant to fitness. However, flexibility training is imperative to maintain full range of motion (ROM) of joints, particularly in individuals with type 2 diabetes, who may experience limited joint mobility due to glycation of joint structures (1). Maladies such as "frozen shoulder" are common complaints in type 2 diabetes (2).

Conflicting evidence exists about the effect of resistance training on flexibility. For healthy adults, such training will improve flexibility as long as exercises incorporate a full ROM, opposing muscle groups (agonist and antagonist) are trained, and flexibility exercises are done. However, combined strength and flexibility training may not be as effective as flexibility training alone for improving joint ROM in shoulder abduction (3), although strength training alone may increase it (4). Thus, the purpose of this study was to determine whether 8 weeks of combined training improves flexibility in older adults with and without type 2 diabetes.

RESEARCH DESIGN AND METHODS

— Nine individuals with type 2 diabetes (5 men and 4 women) and 10 sedentary control subjects (6 men and 4 women) participated. The mean age for the two groups (type 2 diabetic and control subjects) was 50.6 ± 2.8 and 54.7 ± 2.8 years, respectively, and BMI was similar prior to training (32.0 ± 2.4 and 33.1 ± 1.4 kg/m^2). Height, weight, fasting blood, body composition (skinfolds), and resting 12-lead electrocardiogram data were collected, as well as peak aerobic capacity ($V\text{O}_2$ peak) on a cycle ergometer. All measurements were repeated exactly 48–72 h following the completion of training.

Tests of flexibility included those taken with an inclinometer (spine, knee flexion, and hip flexion and extension) and shoulder ROM, prayer sign (5), and modified sit-and-reach flexibility tests. Subjects performed one-repetition maximum (1-RM) testing at a local YMCA on eight different resistance training machines (five upper and three lower body).

Subjects performed flexibility and resistance training on 3 nonconsecutive days of the week over an 8-week period. During each training session, they performed three sets of 8–12 repetitions of each of the eight exercises for which their 1-RM had been determined, done at 50, 60, and 70% of their individual 1-RM (6). After each exercise session, subjects performed various standard flexibility exercises that stretched the major muscles groups of the chest, shoulders, and legs for 10–30 s each.

Subject characteristics were compared using Student's t tests. Repeated-measures ANOVA was used to compare type 2 diabetic and control groups on measures of strength and flexibility. The level of significance was set at $P < 0.05$.

RESULTS

— Type 2 diabetic and control subjects were well matched for age, body weight, BMI, percent body fat, and $V\text{O}_2$ peak. Type 2 diabetic subjects differed from control subjects only on their overall blood glucose control (HbA_{1c}), which was higher in the type 2 diabetic group (pretraining 7.2 ± 0.3 vs. 5.7 ± 0.1%) and not significantly lowered by training.

Individual measures of flexibility were similar between the type 2 diabetic and control groups both before and after training. Only the type 2 diabetic group, however, significantly improved on any flexibility measure with training, specifically the modified sit-and-reach, left knee flexion, and left hip flexion measures; no measure for control subjects improved significantly. Additionally, the type 2 diabetic group increased overall lower body flexibility (including right and left knee flexion and hip flexion/extension) significantly more than control subjects (Fig. 1).

As for strength testing, the 1-RM values for type 2 diabetic subjects did not differ from control subjects before or after training. Both groups exhibited significant strength gains, though, on almost every resistance machine tested, with unchanged peak aerobic capacity.

CONCLUSIONS

— Eight weeks of combined flexibility and resistance training caused significant strength gains in older adults with and without type 2 diabetes. Flexibility gains were somewhat limited but occurred only in the type 2 diabetic subjects despite similar initial levels of flexibility.

The average strength increases of 36 and 41% for upper and lower body exercises, respectively, after 8 weeks of thrice-weekly resistance training are similar to prior research (7,8). Subjects doing circuit weight training for 8 weeks have experienced strength gains ranging from 15 to 43% (7). Adults with type 2 diabetes, impaired glucose tolerance, or hyperinsulinemia have also shown a 38 and 50%

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Abbreviations: 1-RM, one-repetition maximum; ROM, range of motion.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

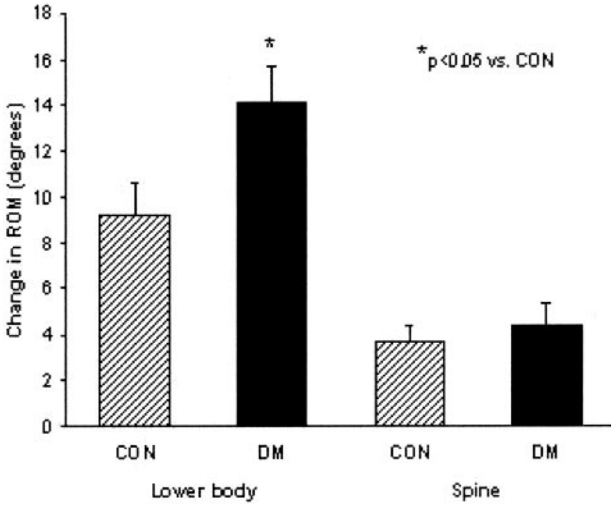

Figure 1—*Change in combined lower body and spine flexibility measures following 8 weeks of flexibility and resistance training. CON, control subjects; DM, type 2 diabetic patients.*

increase in upper body and lower body strength, respectively, after 20 weeks of variable resistance training (8).

In healthy populations, combined strength and flexibility training is not as effective as flexibility training alone for improving joint ROM in shoulder abduction (3). In older adults, both strength training alone and combined strength and aerobic training increase joint ROM significantly when compared with aerobic alone or no training (4). In older women, sit-and-reach test flexibility improves by 13% from 10 weeks of resistance training alone (5). It is impossible to discern what effect the resistance training per se had on our subjects, since flexibility training also occurred, but type 2 diabetic subjects alone exhibited significantly improved sit-and-reach scores from the combination.

Undeniably, individuals with type 2 diabetes are more prone to contractures that can potentially limit joint mobility (2,9). Loss of shoulder ROM is related to the duration of diabetes and the presence of other diabetes complications (10). None of our subjects, however, had any shoulder joint limitations or severe diabetes-related complications before training. Moreover, the type 2 diabetic subjects had mean blood glucose levels that were elevated, although not severely, above normal values. Thus, it is likely that our type 2 diabetic subjects may have been experiencing fewer joint limitations than a more poorly controlled diabetic population (9). Still, only type 2 diabetic subjects significantly improved flexibility following training, perhaps overcoming more subtle deleterious effects of diabetes on joint mobility.

In conclusion, older adults with type 2 diabetes without impaired flexibility may still enhance certain measures of joint ROM by participating in combined strength and resistance training. Diabetes per se does not preclude such individuals from participating in resistance training and from improving strength.

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