

# Combined Aerobic and Resistance Exercise for Patients With Type 2 Diabetes

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**T**YPE 2 DIABETES MELLITUS IS A MAJOR RISK FACTOR FOR excess morbidity and mortality. The excess vascular risk in type 2 diabetes is attributable both to hyperglycemia<sup>1,2</sup> and to other metabolic disturbances associated with abdominal obesity, insulin resistance, and compensatory hyperinsulinemia. Sedentary lifestyle is also a major cardiovascular risk factor,<sup>3</sup> and regular exercise attenuates the vascular risks associated with type 2 diabetes.<sup>4,5</sup> Aerobic exercise refers to activities such as walking or jogging with continuous, repetitive movement of large muscle groups for at least 10 minutes at a time, whereas resistance exercise refers to activities such as weight lifting that use muscular strength to move a weight or work against a resistance load. Aerobic exercise for individuals with diabetes has been recommended for many decades,<sup>6</sup> but the American Diabetes Association only began recommending resistance exercise in 2006.<sup>7</sup>

In this issue of JAMA, Church and colleagues<sup>8</sup> report the results of the Health Benefits of Aerobic and Resistance Training in Individuals with Diabetes (HART-D) trial. This study provides important evidence on the effects of aerobic and resistance training on improving hemoglobin A<sub>1c</sub> (HbA<sub>1c</sub>) levels. In this trial, 262 previously sedentary patients with type 2 diabetes were randomized to a sedentary control group or to 1 of 3 exercise groups: aerobic exercise, resistance training, or a combination of both. Patients in the combined group performed smaller amounts of aerobic and resistance exercise than those in groups performing just one type of exercise so that the total amount of time devoted to exercise each week was similar among the 3 groups. The aerobic group performed 1.2 kcal/kg of body weight per week of aerobic exercise, equivalent to walking briskly at 4 mph for about 50 minutes per session 3 times a week. The resistance training group performed 2 to 3 sets of 10 to 12 repetitions of 9 exercises 3 times a week. The combined group performed 10 kcal/kg of body weight per week of aerobic exercise (equivalent to 42 minutes 3 times a week of walking at 4 mph, 83% of the amount done by the aerobic group) plus 1 set each of 9 exercises 2 times a week (less than a third of

the resistance training volume performed by the resistance training group). No efforts were made to minimize changes in diet or medications.

Only the combined training group achieved statistically significant reduction in absolute reduction in HbA<sub>1c</sub> in the HART-D trial compared with the control group (0.34%). The aerobic group had an absolute reduction of 0.24%; the resistance group, 0.16%. All groups had modest and similar decreases in waist circumference compared with the control group. In addition to the greatest HbA<sub>1c</sub> reduction, the combined training group also had the most decreases, and the least increases, in use of hypoglycemic medication.

The findings of the HART-D trial are important for several reasons. First, the study duration was 9 months, making it longer than most exercise intervention trials involving patients with diabetes. Second, the study population was relatively large in number (n=262) and ethnically diverse, with almost 44% of participants being African American, and had a relatively high proportion of female participants (63%). Third, the total time spent exercising was roughly the same in the combined training group as in the other 2 single-exercise groups. Therefore, any difference between the combined exercise group and the other exercise groups can be confidently attributed to the combination of 2 types of exercise rather than the amount of time spent exercising.

The HbA<sub>1c</sub> changes achieved in the HART-D trial were modest, perhaps because there was no effort to minimize medication changes. Participants whose HbA<sub>1c</sub> level did not improve with exercise were more likely to have their hypoglycemic therapy intensified, thus attenuating the difference in HbA<sub>1c</sub> that could be achieved between groups. It is likely that intergroup HbA<sub>1c</sub> differences in HART-D may have been greater if medication changes had been discouraged. The results are encouraging in that a significant incremental improvement in glycemic control was made in the HART-D combination group over and above that achieved through ongoing efforts by physicians and patients in both groups to optimize glycemic control with medications. Another possibility is that the higher proportion of women and

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nonwhite participants in HART-D could have contributed to the relatively small effects of exercise on HbA<sub>1c</sub>. However, race- and sex-specific outcome data were not reported, and the sample size was probably insufficient to have adequate power for such subgroup analyses.

The results of the HART-D trial add to findings from an earlier study, the Diabetes Aerobic and Resistance Exercise (DARE) trial,<sup>9</sup> which also suggested that combined aerobic and resistance exercise was more effective than either type of exercise alone for improvement of glycemic control in type 2 diabetes. In the DARE trial, 251 previously sedentary adults with type 2 diabetes and an average baseline HbA<sub>1c</sub> level of 7.5% were randomized to 4 groups: aerobic exercise training (progressing from 15 to 45 minutes per session and increasing in intensity from 60% to 75% of maximum heart rate), resistance exercise training (progressing from 1 to 3 sets of 8 repetitions of 7 exercises per session), combined aerobic and resistance training, or a waiting-list control. The same dietary recommendations and supervision were provided to all groups, and patients and their physicians were instructed not to make any changes in medications for glycemia, blood pressure, or lipids unless considered medically imperative. Absolute HbA<sub>1c</sub> changes compared with the control group were -0.51% in the aerobic training group, -0.38% in the resistance training group, and -0.97% in the combined aerobic and resistance training group. These were clinically significant changes because a 1% absolute increment in HbA<sub>1c</sub> is associated with a 21% increment in major diabetes-related adverse outcomes.<sup>10</sup>

Exercise training in both the HART-D trial and the DARE trial was based in exercise facilities and closely supervised by qualified trainers. The results obtained in these trials may be better than what can be expected if patients attempt these interventions at home because prior studies of home-based resistance training did not demonstrate improved glycemic control.<sup>11,12</sup> Likewise, supervised interventions tend to be more effective than unsupervised ones.<sup>13</sup> This is a common theme for lifestyle interventions. Obesity is indeed treatable if supervised diet and exercise programs are provided at no cost to patients,<sup>14,15</sup> whereas these types of interventions appear to be less successful when implemented by patients by themselves.

Based on the results of the HART-D trial, patients with type 2 diabetes who wish to maximize the effects of exercise on their glycemic control should perform both aerobic

and resistance exercise. The HART-D trial clarifies that, given a specific amount of time to invest in exercise, it is more beneficial to devote some time to each form of exercise rather than devoting all the time to just one form of exercise.

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