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Four-Year Follow-up after Two-Year Dietary Interventions

TO THE EDITOR: Data from trials that compare the effectiveness of weight-loss diets are frequently limited to the intervention period. In our 2-year

workplace-based study, called the Dietary Intervention Randomized Controlled Trial (DIRECT),^{1,2} we randomly assigned 322 moderately obese

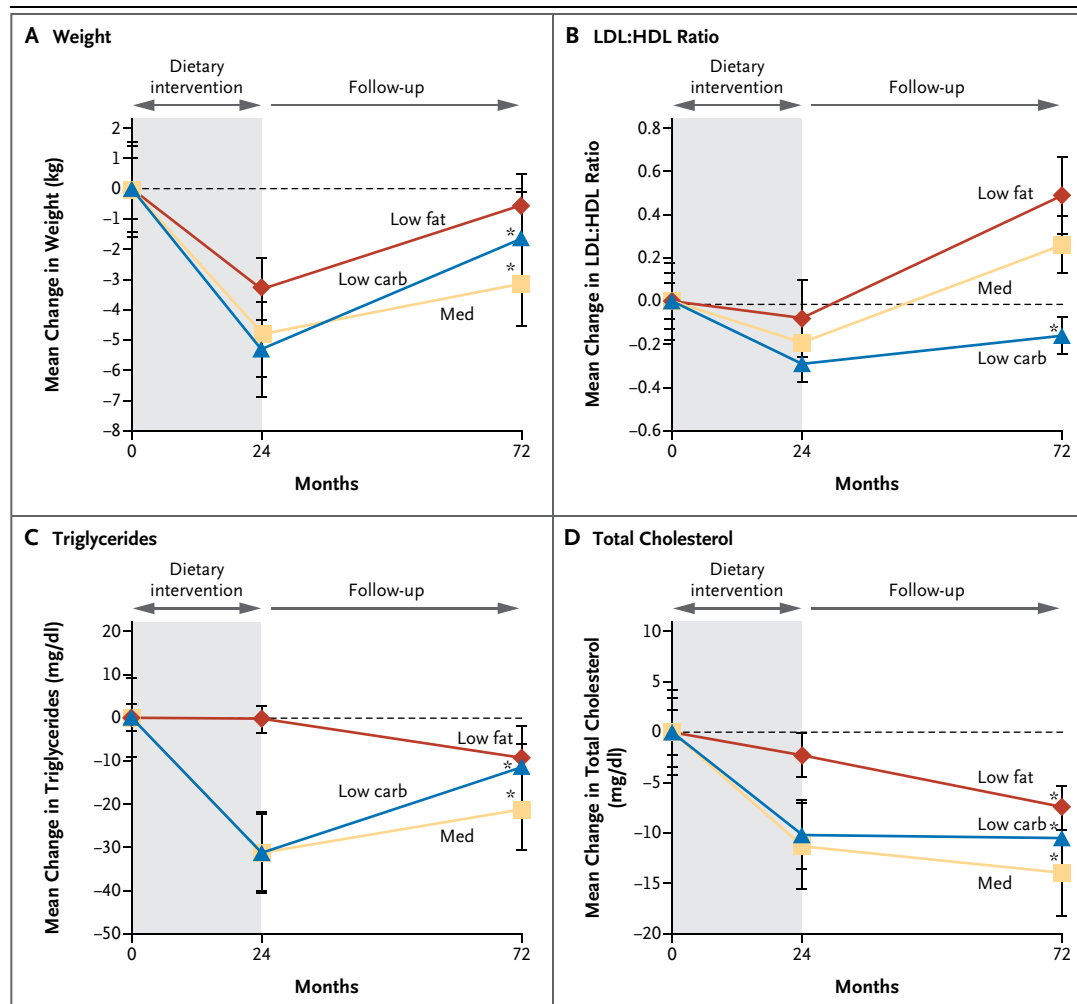


Figure 1. Changes from Baseline in Diet-Related Measures.

Shown are mean changes from baseline in weight (Panel A), the ratio of low-density lipoprotein (LDL) cholesterol to high-density lipoprotein (HDL) cholesterol (Panel B), triglyceride levels (Panel C), and total cholesterol levels (Panel D) in 322 moderately obese participants who were assigned to one of three weight-loss plans: a low-fat, restricted-calorie diet (Low fat); a Mediterranean, restricted-calorie diet (Med); or a low-carbohydrate diet without calorie restriction (Low carb). The duration of the original study was 2 years (as indicated by the shaded portion of the graph). Four-year follow-up analyses were conducted in 259 of the original participants. LDL and HDL were measured in milligrams per deciliter. Asterisks denote $P < 0.05$ for the difference from baseline at 6 years. The I bars indicate standard deviations.

participants to one of three weight-loss plans: a low-fat, restricted-calorie diet; a Mediterranean, restricted-calorie diet; or a low-carbohydrate diet without calorie restriction. The mean age of the participants was 52 years, and the mean body-mass index (the weight in kilograms divided by the square of the height in meters) was 31; 86% of the participants were men. We provided nutrition labeling and diet-group color coding daily in the workplace cafeteria. We also performed a spousal education program.³

At 2 years, the adherence rate was 85%, with evidence of distinct dietary patterns in the three diet groups. After 2 years,¹ the mean weight loss was 2.9 kg in the low-fat group, 4.4 kg in the Mediterranean group, and 4.7 kg in the low-carbohydrate group. In addition, we found that there was a significant diet-induced regression in volume in the carotid-vessel wall.⁴ After the 2-year intervention was completed, we followed the participants for 4 more years. (Details are provided in the Supplementary Appendix, available with the full text of this letter at NEJM.org.)

We next performed an intention-to-treat analysis across the assigned diets, with 4-year follow-up among 259 participants (80.4% of the original group and 95.2% of those who had completed the 2-year trial). At 6 years after study initiation, 67% of the participants had continued with their originally assigned diet, 11% had switched to another diet, and 22% were not dieting ($P=0.36$ for all comparisons). During this follow-up period, participants had regained 2.7 kg of weight lost in the low-fat group, 1.4 kg in the Mediterranean group, and 4.1 kg in the low-carbohydrate group ($P=0.004$ for all comparisons).

For the entire 6-year period, the total weight loss was 0.6 kg in the low-fat group, 3.1 kg in the Mediterranean group, and 1.7 kg in the low-carbohydrate group ($P=0.01$ for all comparisons) (Fig. 1A). There was a significant difference in total weight loss between the low-fat group and the Mediterranean group ($P=0.01$) but not between the low-fat group and the low-carbohydrate group ($P=0.44$) or between the Mediterranean group and the low-carbohydrate group ($P=0.22$). Overall, as compared with the weight at baseline, the 6-year weight loss was significant for the Mediterranean group ($P<0.001$) and the low-carbohydrate group ($P=0.02$) but not for the low-fat group ($P=0.28$).

At 6 years, changes from baseline in the ratio

of low-density lipoprotein cholesterol to high-density lipoprotein cholesterol were similar in the three groups ($P=0.62$ for all comparisons), although the change in the ratio was significant in the low-carbohydrate group (a reduction of 0.16, $P=0.04$) (Fig. 1B). Reductions in triglyceride levels from baseline were significant in the Mediterranean group (21.4 mg per deciliter [0.24 mmol per liter], $P=0.03$) and the low-carbohydrate group (11.3 mg per deciliter [0.13 mmol per liter], $P=0.02$), with no significant difference among the three groups ($P=0.12$) (Fig. 1C). Overall, there were persistent and significant reductions from baseline in total cholesterol levels in all three study groups, with reductions of 7.4 mg per deciliter (0.19 mmol per liter) in the low-fat group ($P=0.03$), 13.9 mg per deciliter (0.36 mmol per liter) in the Mediterranean group ($P=0.001$), and 10.4 mg per deciliter (0.27 mmol per liter) in the low-carbohydrate group ($P=0.02$; $P=0.71$ for all comparisons) (Fig. 1D).

In conclusion, a 2-year workplace intervention trial involving healthy dietary changes had long-lasting, favorable postintervention effects, particularly among participants receiving the Mediterranean and low-carbohydrate diets, despite a partial regain of weight.

Dan Schwarzfuchs, M.D.

Nuclear Research Center Negev
Dimona, Israel
dan.nurit@gmail.com

Rachel Golan, R.D., M.P.H.

Iris Shai, R.D., Ph.D.

Ben Gurion University of the Negev
Beer-Sheva, Israel

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