A Review: Which Dietary Plan Is Best for Your Patients Seeking Weight Loss and Sustained Weight Management?

The Writing Group for the Clinical Nutrition Department at Rush University Medical Center: Christy C. Tangney, PhD, CNS, Kristin A. Gustashaw, MS, RD, Teresa M. Stefan, MS, RD, Cheryl Sullivan, MS, RD, Jennifer Ventrelle, MS, RD, Chris A. Filipowski, MS, RD, Andrea Domas Heffernan, MS, RD, and Jacqueline Hankins, MS, RD

Introduction

There are so many diet books available in the popular press.1 Because of the extensive news coverage and often conflicting cautionary statements about diet plans to counter weight gains, more attention must be paid to the safety and the efficacy of such diets.2-4 The data are truly limited with respect to sustainability of the commercial weight loss programs and popular diets. The goal of this review is to provide a concise update on the efficacy of many of these plans on maintenance of weight lost where follow-up of patients is at least 1 year.

To lose weight, an energy imbalance must be initiated through either activity or dietary means. If no increased activity is planned, the food energy consumed must decrease. A calorie spent or consumed is still a calorie.5 All dietary plans designed to promote weight loss will restrict energy consumption either unintentionally,6 or intentionally through planned satiation.7-9 Many popular weight loss diets provide quick weight loss, since they are simple to follow in the short-term (avoidance of specific food groups), but difficult to adhere to long-term. An examination
of the attrition rates and, wherever possible, adherence to diet and physical activity behaviors (if required for the program treatment) is also needed.

The limitation of many programs or diet strategies is not the documentation of weight loss by 3 to 8 weeks, but whether the adopted plan or some modification of the plan demonstrates successful weight loss long-term at 1 or 2 years. Likely a successful or efficacious weight loss plan is one that fits one’s food preferences, budget, and lifestyle and daily challenges. Without such a personalized approach, continued weight loss or the prevention of weight regain will be unlikely. Furthermore, long-term dietary intake not only affects body weight status, but also potentially future risk from chronic disease. As we continually learn more about the influence of dietary patterns on chronic disease, we will better be able to educate the public to eat to live without disease!

Selected Dietary Plans

Focus: Low-Fat Low-Calorie Plans

The low-fat diet has been promoted by many scientific organizations and governmental agencies. In the Third Report of the National Cholesterol Education Program (NCEP) expert panel in Detection, Evaluation, and Treatment of high blood cholesterol in adults (Adult Treatment Panel III or ATP III) released in May 2001, the new Therapeutic Lifestyle Changes (TLC) program, a multifaceted lifestyle approach to reduce risk of coronary heart disease (CHD), was introduced. The TLC dietary approach is based on the documented benefits of the NCEP step II diet and draws on new research indicating the use of specialty nutrients to achieve further reductions in blood cholesterol lowering. The TLC diet is the characteristic low-fat diet (30% of energy from total fat), about the average protein content (15% of energy), and may incorporate up to 20% of energy from monounsaturated fats. Moreover, it emphasizes 20 to 30 g fiber per day. The TLC/Step II diet translated into a food guide is shown in Table 1.

Although the TLC plan was not specifically designed to effect weight loss per se, both regular physical activity and a healthy weight are also critical complements to the TLC diet. Weight loss can be achieved with the TLC plan when portion size and caloric restrictions are adhered to and when increased energy expenditure through physical activity is encouraged.

Probably the best example of potential efficacy of a lifestyle program that incorporates the TLC-like low-fat diet is that used by assigned
participants to the intensive lifestyle treatment arm in the Diabetes Prevention Program. In this 4-year randomized clinical trial, more than 3200 overweight or obese subjects with impaired glucose tolerance were assigned to one of the three following treatments: (1) standard lifestyle treatment plus metformin; (2) standard lifestyle (an annual session emphasizing the importance of a healthy lifestyle) plus placebo; or (3) intensive lifestyle modification (ILT). The latter treatment was designed to provide for sustained weight loss with a 7% weight loss goal through adoption of a low-calorie, low-fat diet and at least 150 minutes of physical activity per week. The latter treatment was the most successful with respect to the primary outcome, reducing incident cases of diabetes with a significantly lower incidence of diabetes—better than that of the metformin arm, which in turn, was significantly better than placebo.

In terms of the weight loss goal, ILT participants lost ~7 kg at the end of the first year and then regained ~1 kg in the ensuing 3 years (Fig 1A).
Achieving the weight loss and activity goals by 6 months was highly predictive (1.5 to 3.0 times more likely) of meeting these goals after 3.2 years.\textsuperscript{12}

Diabetes Prevention Program (DPP) ILT participants ($n = 936$) reported $224 \pm 141$ minutes per week of physical activity at the end of the 16-week core curriculum (\textsim 6 months from baseline), and $227 \pm 212$ min per week of physical activity at the final visit, approximately 3 years later. Subjects in this group were more successful in enhancing physical activity as can be seen in Fig 1B; in this figure, activity is expressed in terms of metabolic equivalents per hour to account for the effort or

\textbf{FIG 1.} Changes in body weight (A) and leisure physical activity (B) according to study group. Each data point represents the mean value for all participants examined at that time. The number of participants decreased over time because of the variable length of time that persons were in the study. For example, data on weight were available for 3085 persons at 0.5 year, 3064 at 1 year, 2887 at 2 years, and 1510 at 3 years. Changes in weight and leisure physical activity over time differed significantly among the treatment groups ($P < 0.001$ for each comparison). Used with permission from Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346:393-403. Copyright © 2002 Massachusetts Medical Society. All rights reserved.
Intensity of activity. The intensity of physical activity may also be critical in the amount of weight lost and maintained. In a long-term study by Jeffery and colleagues, maintenance or prevention of weight gain is critically linked to the intensity of weekly physical activity, particularly when treatment sessions become less frequent (Fig 2). Others have also observed weight loss can be greater at 18 months if individuals exercised 200 minutes or more each week when compared to persons who exercised fewer than 150 minutes per week.

Dietary self-monitoring was also positively related to meeting weight and activity goals. Among ILT participants, daily total energy intakes were significantly reduced; this was accompanied by a reduction in the percentage of energy from total fat, a greater increase in that from carbohydrate, and an increase in dietary fiber when compared to that reported by either of the two other groups at year 1 (Fig 3A, B). The median change was about 450 kcal/day and 6.6% from fat, whereas in the other groups, the comparable figures were −294 and −250 kcal/day, and −0.8% and −0.8% energy from fat. In terms of foods, ILT participants chose to consume more servings of fruits, vegetables, slightly yet

**FIG 2.** Weight change over 18 months in patients treated by behavior therapy combined with low physical activity (ie, 1000 kcal/week) or behavior therapy with high physical activity (ie, 2500 kcal/week). Participants received weekly treatment (Tx) for the first 6 months, which declined to twice monthly from months 7 to 12 and monthly thereafter. Reproduced from reference 13 with permission by the *American Journal of Clinical Nutrition*. © 2003 Am J Clin Nutr. American Society for Clinical Nutrition.
significantly more poultry, and less red meat and dairy, and markedly fewer servings of sweets (Fig 3C).

What is truly remarkable about this study is the uniquely low attrition or dropout rate reported for this trial (8%). In Fig 4, we present a comparison of attrition rates from published weight loss trials or prospective studies; the studies are presented in order of study duration. In contrast, the attrition rates reported for some 20 recent studies (including some included in Fig 4) of lifestyle programs for weight loss average ~20% with ~10 kg loss after 30 weeks of treatment.16

The low-calorie, low-fat (~25% fat), high-fiber (>25 g) program with intensive group support underlies the documented success of Weight Watchers® participants. This commercial program was founded in 1963 and is presented to clients as a point exchange system so that the participant must tally up points each day, with a total allowable dependent on current weight.17 Self-monitoring and frequent (weekly) meetings serve to foster better adherence and long-term success. No formal physical activity program however is in place with the current program. As seen by others,18,19 persistent follow-up is associated with better weight outcomes. Compared to other commercial programs reviewed systematically by Tsai and Wadden this year,3 long-term trial data for the Weight Watchers® program are the most compelling because of the number of subjects (65 obese men and 358 obese women) studied and the duration of follow-up; after 2 years, a weight loss of 3.2% was reported. Specifically, 211 participants were randomized to attend a commercial weight loss program (Weight Watchers®), while 212 were assigned to less structured self-help programs.20 While both treatments were associated with modest weight reduction, losses at 1 and 2 years were greater among subjects in the commercial program (−4.3 and −2.9 kg, respectively) than among those on the self-help treatment (−1.3 and −0.2 kg, Fig 5). While completion rates were similar between the two treatments (71% for the commercial, 75% for self-help), participant effort, specifically, in terms of attendance to meetings, appears associated with greater, sustained weight loss (Fig 6).

The low-fat low-calorie paradigm accompanied by high levels of physical activity is also the mantra of nearly 5000 volunteer patients in the National Weight Control Registry (NWCR, www.nwcr.ws). Eligible participants in NWCR are those who have maintained a weight loss of at least 30 pounds (13.6 kg) for a minimum of 1 year.21,22 Dietary composition of registry participants has changed little over the past decade despite the popularity of low-carbohydrate diets. Ten years ago, a high-carbohydrate diet with ~24% of calories from fat was reported by
the majority of participants. On the basis of a recent NWCR survey, members reported consuming diets with only a slightly higher fat composition (~29%). Hence, members are still consuming diets high in carbohydrates and low in fat.

**Extremely Low-Fat Diets: Ornish Diet**

More than a decade ago, Ornish and colleagues were among the first to test whether lifestyle changes in diet, stress, exercise, and other habits
could reverse heart disease. The Lifestyle Heart Trial was one of the first randomized clinical trials to test the efficacy of this nonpharmacologic approach against usual care in ambulatory patients with documented coronary atherosclerosis; the primary outcome, a decrease in coronary stenosis, was correlated to the degree of change in lifestyle after 1 year. A 5-year follow-up of those trial participants (n = 35) also supported these outcomes. Patients in the experimental group lost 10.9 kg at 1 year and sustained a weight loss of 5.8 kg by 5 years, whereas weights of control group patients changed only slightly. However, lifestyle assigned patients were heavier at baseline (BMI, 28.4 ± 4.1 versus 25.4 ± 3.5 for control, P = 0.03). The Ornish low-fat dietary plan is a comprehensive lifestyle plan that incorporates a 10% fat dietary plan with moderate aerobic exercise, stress management training, smoking cessation, and group psychosocial support; further details are provided elsewhere. Further description of the 1-year changes in 440 men and women with heart disease recruited through hospitals who adopted the Ornish program is available in a recent report. Nearly 27% of women and 21% of men did not complete the 1-year follow-up. Weight lost for women averaged 5.6 kg, for men, 4.4 kg. These results were less marked when compared to the Lifestyle Heart trial results, in part due to the low levels of adherence and high attrition rates.

FIG 3. Continued C. Change in consumption of foods, baseline to 1-year postrandomization, by treatment group. Statistical significance for pairwise comparisons (P < 0.003) is shown only when overall treatment effect was demonstrated (P < 0.01).
The shift in the popularity of weight loss diets that emphasize carbohydrate restriction, protein enrichment, and even a liberalization of fat intake may be a consequence of relatively slow rates of weight loss.

**FIG 4.** Attrition rates of various weight loss studies from the shortest in duration 12 weeks [Aude, ref. 39] at the bottom right to the top right, a study of 5 years [Koertge, ref. 26]. WW = Weight Watchers; ILT = Intensive Lifestyle Treatment.

---

**Mediterranean (Monounsaturated-Omega 3 Enriched) Plans (Moderate Fat)**

The shift in the popularity of weight loss diets that emphasize carbohydrate restriction, protein enrichment, and even a liberalization of fat intake may be a consequence of relatively slow rates of weight loss.
that many clients experience and, thus, a contributor to poor long-term compliance. A more moderate fat plan emphasizing monounsaturated (MUFA) and omega-3 fats may also afford benefits other than weight loss, including improved cardiovascular profiles, and overall lower cardiovascular and total mortality.27-29

One of the best examples of a Mediterranean-style dietary plan and its potential efficacy in weight loss is that of a recent single-blind trial of 180 patients (99 men and 81 women) diagnosed with metabolic syndrome conducted at a university hospital in Italy from 2001 to 2004.30 Exactly 90 patients were randomized to the Mediterranean style diet plan (still low-fat with 28 to 30% energy as fat, 13 to 15% as protein, 55 to 60% as carbohydrate), but higher in MUFA (~12% energy) and omega-3 (>1 g/day) in which they were instructed on how to increase servings of whole grains (400 g legumes, rice, maize, wheat), fruits, vegetables, nuts (25 to 50 g walnuts per day), and olive oil in monthly sessions for the first year and bimonthly in year 2. The 90 control group subjects were given written and oral instructions on a prudent diet (<30% of energy from fat, 50 to

The typical Mediterranean diet plan is one composed of moderate fat (35% of energy), where monounsaturated fats contribute 15% or more of energy.31
60% carbohydrates, and 15 to 20% protein), but had fewer meetings with study personnel—only bimonthly throughout the 2-year period. Both groups received advice to increase level of physical activity by walking at least 30 minutes each day and adding aerobic activities. The Mediterranean diet participants experienced a significantly greater weight loss, 4.0 ± 1.1 kg versus 1.2 ± 0.6 kg, \( P < 0.001 \), improved insulin sensitivity, \( P < 0.001 \), along with significant reductions (all \( P < 0.001 \)) in serum insulin and lipid levels when compared to the those assigned the prudent diet. These changes paralleled the documented dietary changes in the experimental group, where intakes of total energy were on average 100 kcal lower; for carbohydrate as a percentage of energy, 1% higher; fiber, higher by 16 g; saturated fat, lower by 5.3% of energy; MUFA, higher by 3% (of energy); and omega-3 fats, higher by 0.9 g daily than those of the control group patients. One alternative explanation for this outcome may be the greater attention, support, and demands placed on those assigned the Mediterranean diet plan. The reported attrition rates (Fig 4) were similar between the two groups (\( \sim 9\% \)) and would argue against such an explanation.

Focus: Low-Carbohydrate Plans

The central rationale of a low-carbohydrate diet is that severe restriction of dietary carbohydrate (<10% of daily caloric intake), with its resulting ketosis, promotes lipid oxidation, satiety, and increased energy expenditure, factors that should promote negative energy balance and weight loss.6,32 However, these purported responses to very low-carbohydrate feeding have not been conclusively established in the literature.

Low-carbohydrate plans such as the Atkins diet6,32 derive large proportions of calories from protein (usually greater than 15% of energy) and fat (greater than 30% of energy). Nutrition scientists have been concerned about the potential atherogenicity of such diets long-term. Until recently, no controlled long-term studies of these plans had been published. Moreover, proponents of most low-carbohydrate plans claim that energy or calories are not restricted, but unintentionally that is often an outcome, if food intakes are reported (Fig 7).33 This reflects one of the first published trials testing the 6-month efficacy of the low-carbohydrate diet in which dietary information of study participants are reported. Exactly 53 healthy obese women were randomly assigned to either a very low-
carbohydrate diet\textsuperscript{6} or a calorie-restricted, low-fat TLC (Table 1) diet for 6 months. No instructions on changing normal physical activity patterns were given to either group. Those assigned the low-carbohydrate arm were instructed to follow an ad libitum diet with a maximum intake of 20 g carbohydrate/day for the first 2 weeks and then were permitted to increase carbohydrate intakes to 40 to 60 g/day if urinary tests of ketones continued to be positive. Body weight (Fig 8), as well as fat mass and lean body mass, decreased in both dietary treatment groups but significantly more ($P < 0.01$) in the very low-carbohydrate group compared with the low-fat group at both 3 and 6 months.

Two 1-year randomized controlled trials designed to assess the weight loss efficacy of the low-carbohydrate diet against the low-fat diet\textsuperscript{6} or a calorie-restricted, low-fat TLC (Table 1) diet for 6 months. No instructions on changing normal physical activity patterns were given to either group. Those assigned the low-carbohydrate arm were instructed to follow an ad libitum diet with a maximum intake of 20 g carbohydrate/day for the first 2 weeks and then were permitted to increase carbohydrate intakes to 40 to 60 g/day if urinary tests of ketones continued to be positive. Body weight (Fig 8), as well as fat mass and lean body mass, decreased in both dietary treatment groups but significantly more ($P < 0.01$) in the very low-carbohydrate group compared with the low-fat group at both 3 and 6 months.

Two 1-year randomized controlled trials designed to assess the weight loss efficacy of the low-carbohydrate diet against the low-fat TLC (Table 1) diet for 6 months. No instructions on changing normal physical activity patterns were given to either group. Those assigned the low-carbohydrate arm were instructed to follow an ad libitum diet with a maximum intake of 20 g carbohydrate/day for the first 2 weeks and then were permitted to increase carbohydrate intakes to 40 to 60 g/day if urinary tests of ketones continued to be positive. Body weight (Fig 8), as well as fat mass and lean body mass, decreased in both dietary treatment groups but significantly more ($P < 0.01$) in the very low-carbohydrate group compared with the low-fat group at both 3 and 6 months.

Two 1-year randomized controlled trials designed to assess the weight loss efficacy of the low-carbohydrate diet against the low-fat TLC (Table 1) diet for 6 months. No instructions on changing normal physical activity patterns were given to either group. Those assigned the low-carbohydrate arm were instructed to follow an ad libitum diet with a maximum intake of 20 g carbohydrate/day for the first 2 weeks and then were permitted to increase carbohydrate intakes to 40 to 60 g/day if urinary tests of ketones continued to be positive. Body weight (Fig 8), as well as fat mass and lean body mass, decreased in both dietary treatment groups but significantly more ($P < 0.01$) in the very low-carbohydrate group compared with the low-fat group at both 3 and 6 months.

Two 1-year randomized controlled trials designed to assess the weight loss efficacy of the low-carbohydrate diet against the low-fat TLC (Table 1) diet for 6 months. No instructions on changing normal physical activity patterns were given to either group. Those assigned the low-carbohydrate arm were instructed to follow an ad libitum diet with a maximum intake of 20 g carbohydrate/day for the first 2 weeks and then were permitted to increase carbohydrate intakes to 40 to 60 g/day if urinary tests of ketones continued to be positive. Body weight (Fig 8), as well as fat mass and lean body mass, decreased in both dietary treatment groups but significantly more ($P < 0.01$) in the very low-carbohydrate group compared with the low-fat group at both 3 and 6 months.

Two 1-year randomized controlled trials designed to assess the weight loss efficacy of the low-carbohydrate diet against the low-fat TLC (Table 1) diet for 6 months. No instructions on changing normal physical activity patterns were given to either group. Those assigned the low-carbohydrate arm were instructed to follow an ad libitum diet with a maximum intake of 20 g carbohydrate/day for the first 2 weeks and then were permitted to increase carbohydrate intakes to 40 to 60 g/day if urinary tests of ketones continued to be positive. Body weight (Fig 8), as well as fat mass and lean body mass, decreased in both dietary treatment groups but significantly more ($P < 0.01$) in the very low-carbohydrate group compared with the low-fat group at both 3 and 6 months.

Two 1-year randomized controlled trials designed to assess the weight loss efficacy of the low-carbohydrate diet against the low-fat TLC (Table 1) diet for 6 months. No instructions on changing normal physical activity patterns were given to either group. Those assigned the low-carbohydrate arm were instructed to follow an ad libitum diet with a maximum intake of 20 g carbohydrate/day for the first 2 weeks and then were permitted to increase carbohydrate intakes to 40 to 60 g/day if urinary tests of ketones continued to be positive. Body weight (Fig 8), as well as fat mass and lean body mass, decreased in both dietary treatment groups but significantly more ($P < 0.01$) in the very low-carbohydrate group compared with the low-fat group at both 3 and 6 months.

Two 1-year randomized controlled trials designed to assess the weight loss efficacy of the low-carbohydrate diet against the low-fat TLC (Table 1) diet for 6 months. No instructions on changing normal physical activity patterns were given to either group. Those assigned the low-carbohydrate arm were instructed to follow an ad libitum diet with a maximum intake of 20 g carbohydrate/day for the first 2 weeks and then were permitted to increase carbohydrate intakes to 40 to 60 g/day if urinary tests of ketones continued to be positive. Body weight (Fig 8), as well as fat mass and lean body mass, decreased in both dietary treatment groups but significantly more ($P < 0.01$) in the very low-carbohydrate group compared with the low-fat group at both 3 and 6 months.
diet have been published. In the study of Stern and colleagues, a highly diverse group (132 white, African American, and Hispanic adults) was recruited at an urban veteran’s hospital; thus, the sample was nearly four-fifths male. [The 6-month data are provided in an earlier article.] The mean weight change for the 87 patients on the low-carbohydrate diet (less than 30 g carbohydrate per day) was $-5.1 \pm 8.7$ kg as compared to $-3.1 \pm 8.4$ kg for the conventional low-fat diet (less than 30% of calories from fat, and a 500 calorie per day reduction). Weight losses did not differ significantly between diet groups. On the low-carbohydrate diet, subjects’ plasma triglycerides decreased more ($P = 0.044$) and HDL cholesterol levels decreased less ($P = 0.025$). Similar to the findings of Brehm and coworkers, subjects on low-carbohydrate diets curtailed energy intake more ($-510 \pm 1187$ kcal) than those on the conventional diet ($-97 \pm 1067$ kcal) by 1 year, though between groups differences were not significant. In the report by Foster and coworkers, 63 obese men and

FIG 9. Mean (±SE) percentage change in weight among subjects on two diets, according to an analysis in which baseline values were carried forward in the case of missing values (A) or an analysis that included data on subjects who completed the study and data obtained at the time of the last follow-up visit for those who did not complete the study (B). Used with permission from Foster GD, Wyatt HR, Hill JO, et al. A randomized trial of a low-carbohydrate diet for obesity. N Engl J Med 2003;348:2082-2090. Copyright © 2003 Massachusetts Medical Society. All rights reserved.
women were randomly assigned to a low-carbohydrate (less than 20 g for the first 2 weeks, then gradually increasing carbohydrates), high-protein, high-fat diet or the low-calorie, low-fat diet. As with the previous report of Stern et al., weight loss change was initially greater among low-carbohydrate subjects, but by 12 months, the weight loss change was not different between diet groups (−4.4 ± 6.7% for low-carbohydrate versus −2.5 ± 6.3% for low-fat, P = 0.26, Fig 9).

No recalled or recorded dietary information was provided in this report. The reported composition of diets subjects consumed on the low-carbohydrate and low-fat treatments from the 6-month long studies of Brehm, Samaha et al., and the year-long one of Stern et al. are summarized in Fig 10, along with other weight loss trials reviewed herein.

Again, in the study by Foster et al., only 59% of subjects completed the year-long study. Judgment of the efficacy of weight loss is compromised by attrition of subjects. Whereas little impact of attrition was observed with analyses of intent to treat, modified intent to treat and completers only in the study of Heshka and coworkers, when smaller subject numbers are studied in each treatment, the impact of sample selection bias may be substantial. If participants drop out because they no longer want to follow the diet, their weight is apt to rebound. That information is then lost if not tracked. One possible approach is to carry forward the baseline value (weight, in this case), because one can assume those who have dropped out will return ultimately to their baseline weight.
**Moderate Carbohydrate (High Protein): The South Beach (SB) Diet**

The South Beach (SB) diet\(^3^8\) actually reflects a mix of both the Atkins and the Mediterranean diets, because it is more moderate in fat and more moderate in carbohydrate content, though Agatson initially does require patients to restrict carbohydrates. The prescribed dietary composition (as described in a recent 12-week-long trial\(^3^9\)) for the last of the three different phases is illustrated in Fig 10. Diet composition is higher in fat (39% of energy) and protein (33% of energy) and the proportion of energy from monounsaturated fats is similar (17%) to the composition of the Mediterranean-style diet.\(^4^0\) When 60 patients (equal proportion of men to women, aged 27 to 71 years, and an average BMI of 35) were randomly assigned to either the NCEP diet or the SB diet, greater weight loss was seen for the SB clients (−6.2 ± 1.8 kg) as compared to those on NCEP (−2.8 ± 2.0 kg).\(^3^9\) These changes were significant between groups (\(P = 0.02\)), though observed reductions in waist girth and circulating lipids did not differ between treatments. The demonstrated efficacy of this diet with respect to long-term weight loss is lacking, because findings provided are for only a 12-week period. Further long-term randomized controlled studies of this dietary plan are needed. Moreover, an ongoing survey of SB diet users with repeated recalls of diet and physical activities, along with self-reported weights, would be an attractive complement to the NWCR survey membership.

**Focus: High-Protein Diet Plans**

Many high-protein diets are, in fact, low-carbohydrate diets, as is the aforementioned SB diet. However, if one controls fat and doubles the proportion of energy from protein (−25 to 30% of energy), we have another weight loss strategy. The rationale behind this plan is that higher protein intake contributes to increased satiety and possibly increased dietary thermogenesis. Increased satiety, of course, may lead to decreased energy intake. At least in the short-term (less than 6 months), more weight loss is observed with the higher protein composition but only with ad libitum intake.\(^4^0\) When diets are isocaloric, the data are not convincing that greater weight loss can be achieved.\(^9^,4^1,4^2\)

What is truly impressive with one report of the Danish trials\(^4^3\) is the considerably long follow-up of 50 overweight and obese subjects who were on one of two strictly controlled diet interventions (where all food was provided and recorded) for 6 months, followed by another 6 months of dietary counseling (three sets of 7-day food records), and then a
24-month follow-up. Subjects were randomized to an ad libitum fat-reduced diet (30% of energy) either high in protein (25% of energy) or medium in protein (12%). Consistent with the purported mechanism of increased satiety, energy intakes were significantly reduced among subjects assigned the high-protein (HP) diets as compared to the medium-protein (MP) diets, but thereafter, there were no differences in energy intakes.

As observed with the Foster\textsuperscript{35} and Stern\textsuperscript{34} studies, the initial difference in the weight loss (greater with the HP plan) between diet groups at 6 months was not preserved by 12 months or at the final 24-month follow-up (Fig 11). As can be seen in the figure, the average weight loss from both groups at 12 months was $-6.2$ kg (range, $-3.8$ to $-8.6$ kg) for the HP group and $-4.3$ kg ($-2.2$ to $-6.4$ kg) for the MP group. At 24 months, the maintained weight loss in the high protein group was double ($-6.4$, $2.6$ to $10.2$ kg) that of the medium protein group ($-3.2$, $-1.5$ to $-7.9$ kg), but again no significance was observed, in part, due to the large

dropout rates. However, as observed at 6 months, significantly larger reductions in waist circumferences (−8.4 cm versus −1.8 cm, \( P = 0.0006 \)) and in intraabdominal fat (−22.0 cm\(^2\) versus −10.5 cm\(^2\), \( P = 0.03 \)) were seen among the HP subjects as compared to MP subjects at 1 year as well.

Attrition is a major limitation in this study because the sample size per group is relatively small. The authors state that attrition rates did not differ significantly between the diet groups: for the MP diet arm, 28% at 6 months and 76% by the end of the 24-month follow-up; the comparable rates were 8% at 6 months and 56% after the 24-month follow-up for the HP group.

These investigators suggest that maintenance of weight loss is better on the HP diet. As shown in Fig 12, in the HP group 17% of the subjects had lost more than 10 kg after 12 months, whereas none in the MP had done so. This larger loss was also documented at 24 months, 2 on HP with greater than 10 kg still lost, and none continued to lose on the MP diet.

Such observations are still preliminary. Further study of the influence of diet composition during weight maintenance on the quality of weight

**FIG 12.** Proportion of subjects having lost and maintained >5 and 10 kg body weight after 6, 12, and 24 months of dietary intervention. Comparisons between groups were made by \( \chi^2 \) test. Difference between medium- and high-protein groups: *\( P < 0.05 \). Used with permission from Due A, Toubro S, Skov AR, et al. Effect of normal-fat diet, either medium or high in protein, on body weight in overweight subjects: A randomized 1-year trial. Int J Obesity 2004;28:1283-1290. Copyright © 2004, Nature Publishing Group.
regain is needed. The composition of the weight regained (how much is fat, how much is fat-free mass) can potentially modify the rate of future weight gain. In a randomized parallel group trial, all 148 male and female patients (BMI 29.5 ± 2.5 kg/m²) were first placed on a very low-energy diet (Modifast® in three sachets daily plus vegetables and fruit only) for 1 month to induce rapid weight loss and then randomly assigned to one of two groups. The first group \((n = 73)\) received an additional 48.2 g of protein per day in the form of one meal replacer (Modifast®) plus two sachets of protein (+ protein), while the other received no additional placebo sachets (− protein). Both groups had the same number of clinic visits and counseling sessions with the dietitian. Compliance to additional protein intake was tracked through urinary nitrogen measurements at 2 months. Physical activity (accelerometer) and resting energy expenditure and substrate oxidation (indirect calorimetry) and body composition (body weight, height, waist circumference, fat-free mass and fat mass, the latter two by doubly labeled water technique) were measured in all subjects. Higher protein intake (18% versus 15% of energy) was associated with lower body weight regain when measured at 3 months (Fig 13). The former (+ protein) group regained less weight (17.3 ± 60.3% versus 36.6 ± 46.8%), had more fat-free mass, less body fat, greater satiety, and smaller waist circumferences than did those of the (− protein) group (Fig 14). Body composition changes shown after a 3-month period must be affirmed with more measurements including measurements of intraabdominal fat as noted by Due and coworkers and after longer intervals.

The Zone diet is defined as a 40% carbohydrate, 30% protein, and 30% fat eating plan that specifically advocates sparing use of grains and cereals. At every eating occasion, a protein:carbohydrate (P:C) ratio is preferred of 0.75 or 3 g protein for every 4 g carbohydrate that is consumed. Hence this diet plan is clearly a lower carbohydrate, high-protein, yet low-fat diet. In fact, in practice, it appears many following the Atkins diet will consume a diet with a P:C ratio of ∼0.77 as illustrated in the study of Brehm et al. (Fig 7). The premise behind this ratio is to shift the insulin:glucagon ratio to one that facilitates fat catabolism. After 6 months of a Zone-like diet (P:C of 0.78) against a conventional (hence, a P:C ratio of 0.24) diet, Linn et al. found no difference in fasting lipid oxidation rates nor in glucagon suppression by insulin. To the best of our knowledge, no formal long-term study of the Zone diet assessing the efficacy of weight loss or weight maintenance appears in the peer-reviewed literature at this time.
Comparison of Diet Strategies and Weight Loss

As described earlier, Dansinger and colleagues\(^2\) tested the 1-year efficacy and adherence rates of four popular diet programs (Atkins, Zone, Weight Watchers, Ornish) in a single center randomized trial of 160 adults (overweight or obese, BMI, 27 to 42) with hypertension, dyslipidemia, or fasting hyperglycemia. All participants were evaluated in terms

of extent of dietary adherence on the basis of two measures. First, nutrient analyses of five sets of 3-day food records at 0, 1, 3, 6, and 12 months were used to create a 10-point score to reflect the degree of success in achieving dietary targets. Second, subjects were called monthly and asked

FIG 14. Changes in FFM and FM (kg ± SD) during 1-month weight loss and 3-months weight maintenance. Additional-protein group: \( n = 73 \); control group: \( n = 75 \). \( *P < 0.01 \) changes over time, compared to baseline. \( *P < 0.05 \): time × group interaction. Used with permission from Westerterp-Plantenga MS, Lejeune MPGM, Van Ooijen M, et al. High protein intake sustains weight maintenance after body weight loss in humans. Int J Obesity 2004;28:57-64. Copyright © 2004, Nature Publishing Group.
to rate their dietary adherence level for the past month. Assuming no change from baseline in those who discontinued (42%), mean weight loss did not differ across diet groups (Fig 15). Approximately 25% of initial participants maintained a 1-year weight loss of more than 5% of initial body weight, and 10% had a 10% loss. Among women, weight decreased by 2.4 \pm 5.1 kg and a waist size by 2.3 \pm 4.5 cm, whereas among males, the comparable changes were 3.3 \pm 6.4 kg and waist by 3.1 \pm 5.8 cm. At 1 year, all four groups experienced reductions in energy intake. At years’ end, there was a tendency ($P = 0.08$) for larger discontinuation rates among the most extreme diets (48% for Atkins, 50% for Ornish) when compared to the moderate diets (35% Zone and 35% for Weight Watchers). As with self-report, diet record adherences declined slowly over time and to a similar extent with each group. Adherence rates were strongly correlated with weight loss ($r = 0.60$, $P < 0.001$, Fig 15). On the basis of the evidence presented thus far, caloric restriction, regardless of diet composition, appears to contribute to weight loss. On the basis of DPP$^{11}$ and other studies,$^{13,14,22,49}$ incorporating more physical activity into one’s lifestyle appears to enhance weight maintenance.
So in lieu of one specific weight loss plan, one can adopt one or more strategies that work for her/him in the context of their food and activity environment. Recently, complementary strategies employed for decades are receiving greater attention in the literature. A brief review of these behaviors is also indicated.

**Alternative Strategies: Emphasis on Portion Size and Energy Density**

**Alternative One: Portion Size**

The trend in larger portion sizes began in the 1970s and has been steadily increasing since then.\(^{50-52}\) These increases have occurred both inside and outside of the home. In 1977 to 1978, 75% of calories were consumed within the home, but in 1994 to 1996, the proportion consumed within the home decreased to 65%.\(^{52}\)

Because the trend in overweight and obesity parallels that of increased portion size availability,\(^{50-52}\) many have proposed that increases in portion sizes of food products may be responsible for the overweight and obesity epidemic. There is a plethora of studies in support of this hypothesis.\(^{53-56}\) What is more limited is the evidence to support the efficacy of portion size reduction intentionally on the part of the individual interested in weight loss long-term.

Nutritionists, home economists, and peer counselors in programs such as Weight Watchers® have taught portion control to clients. Specifically, quantification of the contribution of that behavior to weight loss and maintenance has not been made available in the literature until recently. Logue et al.\(^{57}\) examined portion control as one of four target behaviors (planned exercise, decreased fat, and increased fruit and vegetable intakes were the other three behaviors) in a weight loss regimen designed for 329 middle-aged men and women with BMIs \(>27\) kg/m\(^2\) recruited from 15 primary care practices. This was an 18- to 24-month randomized parallel group trial known as the Reasonable Eating and Activity to Change Health (REACH) study in which the experimental treatment was a minimalist approach based on the Transtheoretical Model versus augmented usual care. The main outcomes were weight loss or weight gain after 1 year. The largest relative risk (RR) estimate for weight loss among the five target behaviors was for increased portion control (RR = 3.84, 95% confidence interval, 1.9, 7.9), suggesting that the most important behavior modification technique for weight loss in this group was accurate identification of portions.

The use of packed portion-controlled entrees compared with a self-
selected diet based on the USDA food guide pyramid has also been recently evaluated in a relatively short-term (8 weeks) study of 60 overweight and obese women who were randomly assigned to one of two groups. The first, the portion-controlled group was instructed to eat prepackaged entrees twice (Uncle Ben’s® bowls; Masterfoods USA, Vernon, CA) per day (one at lunch and one at dinner), while the second group could select their own portions of specific food groups. Both groups were given the same optional choices from fats and oils, desserts, and alcohol and were prescribed the same nutrient composition (55% carbohydrate, 25% protein, 20% fat) and the same approximate calorie level (1365 kcal). The portion-controlled group was more successful that the self-selected diet groups with regard to weight loss (−5.3 ± 2.2 kg versus −3.4 ± 2.6 kg; \( P < 0.01 \)). A concerted effort is required to choose, prepare, measure, and consume foods in the recommended portion sizes. Weight loss and reduced fat mass was easier to achieve when prepackaged entrees were required. Certainly limiting choice to such could be monotonous over much longer periods of time, but does illustrate the potential value of strict portion control in weight management.

Education on portion control is important and dietitians can be an invaluable resource to patients in this regard. Nutrition professionals also often recommend using everyday items to estimate proper portions, such as a serving of meat the size of a deck of cards or the palm of the hand, a piece of fruit about the size of a tennis ball, a serving of cooked pasta or rice about one-half the size of a small fist, and a serving of cheese to be the size of four stacked dice. These methods are often used in conjunction with two-dimensional or three-dimensional food models for education purposes.

Alternative Two: Food Energy Density with Portion Size

It is likely that not only larger portion sizes but also consumption of such portions high in energy density (ie, nondiet soft drinks) contribute to obesity. The mean number of snacks consumed per day for individuals over 2 years of age has increased from 1.1 in 1977 to 1978 to 1.6 in 1995. Zizza and coworkers have also reported that the energy density of snacks has increased. Targeting the energy density of foods, in particular, is a central premise underlying the recently released Volumetrics Eating Plan by Barbara Rolls and that of other plans used for many years.

Weinsier and colleagues used a “time-energy displacement diet” approach with an emphasis on “. . . large volumes of low-energy complex carbohydrates that require more than average time in ingestion, with the
intent to displace more energetically dense items. . .” In this study of 60 patients both men and women were prescribed 1000 kcal per day; daily food records were kept and clinic visits were weekly or biweekly until 20 weeks, when evaluation was performed. No comparison group was studied. Weight loss averaged 8.2 kg during the first 6 months and 0.3 ± 0.1 kg by 17 months of follow-up. The same team from the University of Alabama at Birmingham further refined this weight loss and long-term weight management program (EatRight program) for obese patients. Further retrospective analysis of outcomes of 213 patients provided by this team suggest that 53% of patients maintained their reduced weight or continued to lose weight 2 years later, and only 23% regained all their lost weight. Weight loss was largely predicted by number of visits, not treatment duration. No one factor significantly predicted posttreatment weight rebound. Unfortunately, the success of this program has not be evaluated using a randomized trial design. Thus, the program has not been judged against an alternative or comparison treatment with respect to weight loss outcomes and long-term maintenance.

In the Volumetric Plan, Rolls and coworkers build on a number of concepts that are common to the EatRight program and others. Portion size alone is not solely responsible for increased intake. What causes one to feel satiated and eat no more is also a function of energy density. Energy density refers to caloric value per gram of food. For the same number of kilocalories, a larger weight of food can be ingested if the foods are low in energy density. Water modifies energy density the most because it contributes to weight but has no caloric value. Fat can alter energy density because of its high caloric value, but the water content of a high-fat food can lower the energy density of the food. Dietary fiber can also modify energy density. Examples of water-incorporation and fat-reduction strategies are provided in Fig 16.

Evidence from at least two large-scale cross-sectional population studies support the association between energy density and body weight. Based on dietary recalls from over 13,400 adults (6452 men and 6948 women) in NHANES III, Kant and Graubard reported that energy density was a modest predictor of BMI in both men and women. The odds of having a BMI ≥25 kg/m² were significantly greater for men and women in the highest tertile of energy density of all foods ($P = 0.02$). Moreover, analyses of recall data from more than 9000 adults >19 years old who participated in the 1994 to 1996 Continuing Survey of Food Intake of Individuals (CFSII) support the relationship; low energy-dense diets were associated with lower energy intakes, higher food volume, and lower body weights.
The long-term (1 year) efficacy of these two strategies on body weight has recently been published. In one study, 69 200 overweight and obese men and women were randomly assigned to one of four treatment groups. Subjects in three groups were given supplies of commercially available food low in energy (100 kcal/serving) and fat (<4 g/serving) and instructed to eat a specified amount of the provided food daily during the study: one serving of soup (one-soup group), two servings of soup (two-soup group), or two servings of dry snack foods (two-snack group). Subjects in group 4 were not provided with any specific food to consume (comparison group). The trial had two parts: a 6-month weight loss phase and a 6-month weight maintenance phase. Subjects in all groups were instructed by dietitians on an energy-restricted low-fat diet, to increase physical activity, and learned behavior-modification strategies. 70, 71 During the 6-month weight loss phase, participants were counseled to consume at an energy level 750 kcal/d lower than their needs to facilitate weight loss at a rate of 0.7 kg/week. All were instructed to consume a diet that was 55% of energy as carbohydrate, 30% as fat, and 15% as protein. Those in the two-soup group lost significantly more weight (−7.2 ± 0.9 kg) than those in the two-snack group (who consumed a similar number of kilocalories as energy-dense snacks ie, pretzels, crackers; −4.8 ± 0.7 kg). Surprisingly, the comparison group lost the greatest amount of weight. This was the group in which no foods were given to subjects, but as for subjects in all other groups, received instruction to reduce energy intake. Weight loss was correlated with reduction in energy density from baseline at 1 (r = 0.36, P < 0.0001) and 2 months (r = 0.33, P < 0.0001), but not at 6 and 12 months. Intakes of fiber, fat, protein, and

---

alcohol did not differ. However, sodium intake of the two-soup group was significantly higher than others ($P < 0.0001$). As the investigators note, the success of this low energy-dense diet intervention was limited by the declining soup intake as time progressed. A wider range of food choices of low energy-density value that also require little preparation time are needed to enhance compliance.

If subjects are taught to lower the energy density of their diet in addition to reducing the fat in their diet, even greater weight loss can be expected than in those who are taught to reduce fat intake alone. Specifically, the group counseled to eat more fruits and vegetables lost more weight than those told to eat less fat. Both strategies used to reduce the energy density of the diet in this study did not require participants to count calories or fat grams.\textsuperscript{72} Much more work on the presentation of such strategies, which strategies work best for some, and of course, more long-term studies are needed to maximize efficacy for weight loss programs.

**Alternative Three and More**

Other strategies commonly used for weight management include the following: (1) putting the fork down in between bites of a food to give the body a chance to detect fullness, since it takes about 20 minutes after eating for the hypothalamus to recognize satiety\textsuperscript{73}; (2) drinking plenty of water with meals and before meals; and (3) using a “divided plate system,”\textsuperscript{74} in which the consumer mentally divides the plate into quadrants and fills one section with a protein, another with a starch, and the remaining two with vegetables or a vegetable and a fruit. Other helpful hints include using smaller plates and utensils to reduce intake, or ordering from the kids’ menu when dining out.

**More than One Dietary Plan Can Work Plus More Physical Activity!!!**

Our review of studies that report the success of long-term weight loss programs/diet plans illustrates that there is no compelling evidence for any specific dietary mixture other than energy restriction with respect to long-term weight maintenance. While there are several published studies that provide evidence for the short-term efficacy of their program, there are few “stars” of long-term success in terms of a specific diet plan. Historically, the greatest emphasis has been on low-fat dietary plans. By curtailing fat and potentially alcohol intake (our richest sources of energy per gram), it makes sense that such restrictions constitute one route to achieving weight loss. Second, none of these plans will probably work as efficiently if not combined with increments in physical activity. As shown
in the DPP, participants who increased their physical activity were most successful in losing and maintaining weight (Fig 1). The DPP Lifestyle intervention was designed to facilitate long-term behavioral change as required for sustained weight loss. Similarly, Jeffery and coworkers\textsuperscript{13} found that weight change over 18 months was more favorable among those treated with behavior therapy combined with high physical activity (2500 kcal/week or about 60 min per day) as compared to the same with lower activity prescriptions (1000 kcal/week) (Fig 2).

Third, the success of a weight loss and maintenance program also depends on the quality and number of contacts between caseworker/health professional and subject.\textsuperscript{75,76} An intensive caseworker approach was the one used by the DPP group.\textsuperscript{11} More frequent maintenance therapy is associated with better outcome, as others have shown as well\textsuperscript{18,19} (see Fig 5). Group support may also be critical to weight maintenance. As shown by Renjilian and coworkers, more weight was lost in those receiving group therapy, even among those who said they preferred individual treatment at the outset.\textsuperscript{77}

Weight loss and sustainable maintenance of that loss depends not only upon the food energy consumed (and possibly nutrient composition, as some suggest\textsuperscript{43,44}), the energy expended, the frequency of support therapy/contact, but may also be influenced by other “eating style” factors. Several researchers\textsuperscript{22,78-82} suggest that meal frequency, timing of meals and snacks, and consumption of breakfast daily are factors/behaviors that are important to satiety and an healthy metabolic profile (circulating lipids, glucose, etc). Such studies are short-term, limited in sample, and merit more study. Breakfast skipping has been positively related to BMI after adjustment for other dietary behaviors.\textsuperscript{83} Farshchi and coworkers\textsuperscript{79} have studied the regularity of meals with a unique approach to estimate how patterned eating or lack of such alters the total energy intake per day, thermic effect of food, and hence satiety, as well as the metabolic sequelae, specifically, insulin sensitivity. In their short-term study, they found that an irregular eating pattern was associated with a poorer profile. Again, these studies, though well-designed, are limited in subjects and duration.

Finally, physicians’ encouragement can go a long way to motivate patients to initiate a weight loss strategy\textsuperscript{84,85} and potentially maintain their weight. Women were \textasciitilde 6 times and men \textasciitilde 10 times more likely to report trying to lose weight if they received medical advice as compared to those who did not such. If long-term weight loss or maintenance of that loss is the desired outcome, continued support is necessary.\textsuperscript{71} Indeed, the first three A’s or aspects of an effective weight counseling model (the five
A’s)\textsuperscript{86} are those that the physician should initiate. The five A’s are as follows:

1. Assess obesity risk
2. Ask about readiness to lose weight
3. Advise in designing a weight control program
4. Assist in establishing appropriate intervention
5. Arrange for follow-up.

Arranging for follow-up translates into the continued, periodic support of the physician and the aid of professional weight management teams that include qualified dietitians. The benefits are huge if the patient can prevent weight regain both physically and psychologically.

REFERENCES

home exercise equipment on adherence, weight loss, and fitness in overweight women: a randomized trial. JAMA 1999;282:1554-1560.


51. Smiciklas-Wright H, Mitchell DC, Mickle SJ, et al. Foods commonly eaten the


53. Levitsky DA Youn T. The more food young adults are served, the more they overeat. J Nutr 2004;134:2546-2549.


71. American Dietetic Association and American Diabetes Association (1995) Ex-
76. McCrory MA, Suen VMM, Roberts SB. Biobehavioral influences on energy intake and adult weight gain. J Nutr 2002;132:3830S-3834S.
81. Keim NL, Van Loan MD, Horn WF, et al. Weight loss is greater with consumption of large morning meals and fat-free mass is preserved with large evening meals in women on a controlled weight reduction regimen. J Nutr 1997;127:75-82.