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DIETARY MANAGEMENT OF OBESITY: CORNERSTONES OF HEALTHY EATING PATTERNS

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SYNOPSIS

A number of dietary patterns, both macronutrient and food based, can lead to weight loss. A key strategy for weight management that can be applied across dietary patterns is to reduce energy density. Clinical trials show that reducing energy density is effective for weight loss and weight loss maintenance. A variety of practical strategies and tools can help facilitate successful weight management by reducing energy density, providing portion control, and improving diet quality. The flexibility of energy density gives patients options to tailor and personalize their dietary pattern to reduce energy intake for sustainable weight loss.

Keywords

WEIGHT MANAGEMENT; DIETARY STRATEGIES; ENERGY DENSITY; SATIETY; DIETARY PATTERNS

Introduction

The recent surge in rates of obesity is driven by eating behaviors and food choices that promote excessive energy intake.^{1–8} Current recommendations for weight management emphasize the importance of healthy eating patterns that include a variety of nutrient-dense foods, limit portions of energy-dense foods, and reduce overall energy density.⁸ A number of dietary patterns that reduce energy intake in relation to energy expenditure lead to similar weight loss. A unifying factor for weight loss across dietary patterns is energy density. Reducing a diet's energy density allows individuals to consume satisfying amounts of food for fewer calories. Strategies that lower energy density are flexible and can be applied to

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CONFLICT OF INTEREST: BARBARA J. ROLLS RECEIVES ROYALTIES FROM THE VOLUMETRICS BOOKS.

multiple dietary patterns to match differences in energy needs, taste preferences, eating behaviors, food accessibility, and cultural backgrounds.^{8,9} This article will discuss current evidence related to dietary approaches for weight management, and will provide strategies and tools to create lower-energy-dense eating patterns that can be tailored to the individual to achieve a sustainable and healthy weight management program.

Current Evidence on Dietary Patterns for Weight Loss

Macronutrient patterns for weight loss—Advice to alter the proportion of the macronutrients consumed has been the foundation for many weight loss diets.¹⁰ Fat, carbohydrate, and protein have all been highlighted at different times as the key to weight loss.^{11–13} There continues to be controversy over whether a low-fat or low-carbohydrate diet is better for weight loss, or whether the increased satiating effects of a higher-protein diet help to sustain weight loss.^{10,14} An evidence-based report from the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society supports several energy-restricted dietary approaches for weight loss that focus on the macronutrients, including low-fat, lower-carbohydrate, moderate- and higher-protein, and macronutrient-targeted diets.¹⁵ While such diets can be effective, a number of systematic studies indicate that focusing on a particular macronutrient for weight loss is not necessary. Different macronutrient recommendations have all led to similar clinically significant weight loss at six months, one year, and even two years.^{12,16,17}

One large clinical trial that compared four diets with different proportions of macronutrients, The Preventing Overweight Using Novel Dietary Strategies (POUNDS LOST) study, found that weight loss was similar across the diets (See Figure 1).¹² While the macronutrient composition did not affect weight loss or maintenance of lost weight, regression analysis showed that reductions in dietary energy density and increases in fiber intake were strong predictors for six-month weight loss in all diet groups.^{18–20} The fundamental dietary advice given to participants on all diets included strategies to lower the energy density of the diet, such as increasing vegetable and fruit consumption and decreasing consumption of high-calorie foods.^{12,21} These results suggest that regardless of macronutrient composition, a goal for weight loss should be to adopt a pattern of eating that is lower in energy density.

Food-based patterns for weight loss—In recent years, dietary guidance has emphasized the importance of considering whole diets and patterns of consumption rather than a reductionist approach that focuses on single foods or nutrients.²² For example, the 2015 Dietary Advisory Committee recommends that individuals who have overweight and obesity achieve weight loss by adopting a healthy eating pattern. Examples of such patterns are the Healthy U.S.-Style Eating Pattern, which represents the Dietary Approaches to Stop Hypertension (DASH) diet, and the Healthy Mediterranean-Style Eating Pattern.⁸ The DASH eating pattern recommends reducing intake of the less healthy fats and keeping total fat intake to less than 25% of the diet's energy, as well as increasing the proportion of low-energy-dense foods, such as vegetables and fruits (9 to 12 servings/day) and low-fat dairy products (2 to 3 servings/day).²³ The DASH diet is a lower-energy-dense pattern of eating that allows individuals to consume less energy without reducing the weight of food they typically eat.²⁴ The Mediterranean eating pattern also emphasizes intake of low-energy-

dense fruits, vegetables, legumes, seafood, and dairy foods.²⁵ However, higher amounts of fat (30–40% of total energy), especially from olive oil, are recommended with the Mediterranean pattern.²⁵ Even with this level of healthy fats, the high proportion of vegetables and fruits included in this pattern can help to keep the overall diet relatively low in energy density.²⁶ Table 1 provides guidance on food groups and amounts in several healthy eating patterns.

The influence of energy density on weight management—A key question is whether shifting to a healthy eating pattern that encourages individuals to lower the energy density of their diet will facilitate weight management.^{24,27} This was examined in the large multicenter PREMIER trial in which three intervention groups received information on diet and weight loss, with one group counseled to consume the DASH dietary pattern. Despite differences in treatment, after six months, all three groups experienced similar weight loss. While the average change in energy density of the three groups was similar, there was considerable variability within groups, making it possible to determine whether changes in energy density were related to weight loss. In a secondary analysis that combined the participants from all three groups, results showed that participants with larger reductions in dietary energy density lost more weight than those who had smaller reductions in energy density.²⁴ Furthermore, those who had large or moderate reductions in energy density consumed a greater weight of food and improved diet quality by increasing vegetable and fruit consumption.²⁴ Thus, the adoption of strategies that lowered energy density had a greater impact on weight loss than the specific dietary advice given to the three intervention groups.

Other clinical trials confirm that a lower-energy-dense eating pattern is an effective strategy for weight management.^{28,29} In one trial that compared the incorporation of either a low- or high-energy-dense food into a reduced-calorie diet, the reduction in dietary energy density was the main predictor of weight loss during the first two months of the study.²⁸ Over the year of the trial, the daily consumption of the low-energy-dense food (soup) instead of higher-energy-dense dry snacks with the same calorie content increased the magnitude of weight loss.²⁸ Encouraging regular consumption of low-energy-dense foods can reduce overall dietary energy density and can be an effective strategy for weight management.

Another clinical trial further explored the effectiveness of reducing energy density for weight management by comparing two energy density reduction strategies: reduced-fat or reduced-fat plus increased low-energy-dense vegetables and fruits.²⁹ There were no specific goals for energy intake. After one year, participants in the group focused on eating more vegetables and fruits lost more weight, had a lower dietary energy density, consumed a greater weight of food (especially vegetables and fruits), and reported less hunger compared to participants focused just on fat reduction.²⁹ An increase in the amount of food consumed when managing energy intake will likely improve the long term acceptability of a low-energy-dense eating pattern since it could help to control hunger.

Lowering dietary energy density can also help patients maintain their weight loss.^{30,31} In a clinic-based weight loss program that encouraged consumption of low-energy-dense foods, individuals who maintained their weight loss after two years reported eating a lower-energy-

dense diet than those who regained 5% or more of their body weight.³² In another trial, instruction on reducing dietary energy density led to sustained weight loss 36 months after the start of the intervention.³³

Patients need education on implementing changes in their diet to lower energy density and replicating this in their personal food environment.³³ The strategies individuals use to reduce energy density can fit with a variety of healthy dietary approaches that are popular for weight loss. The next section focuses on dietary energy density, with more in-depth discussion of evidence-based principles that individuals can use to lower energy density and create sustainable eating patterns for weight management.

Unifying principle of dietary patterns: energy density

The energy density of a food or beverage can range from 0 calories per gram to 9 calories per gram, and varies based on the proportions of water (0 calories per gram), fiber (2 calories per gram), carbohydrate (4 calories per gram), protein (4 calories per gram), alcohol (7 calories per gram) and fat (9 calories per gram). Fat is the most energy-dense macronutrient, so when the fat content of a food is reduced, energy density also decreases. Water, however, has the biggest influence on energy density since it adds weight to food without adding calories. The more water a food contains, regardless of the fat content, the lower the energy density of the food. Low-energy-dense foods can help to reduce energy intake by enhancing satiation and satiety through psychological and physiological mechanisms. This leads to terminating a meal sooner, prolonging the time until the next eating occasion, and reducing intake at the next meal.^{34,35}

The energy density of a food or beverage determines the portion size that can be eaten for a given number of calories: the lower the energy density, the larger the portion for the same number of calories. Figure 2 provides a visual example of how the portion size of a 100-calorie snack can vary based on the energy density of the food. For instance, a 100-calorie portion of raisins is about ¼ cup, while the same 100-calorie portion of cherry tomatoes is around 4 cups. As seen in Figure 2, energy density can be explained visually to patients to help them understand the relationship between energy density and the portions that can be consumed. To help further understand this concept, energy density can be divided into four categories: very low energy density, low energy density, medium energy density, and high energy density (See Table 2).³⁴ No matter what dietary pattern an individual uses for weight loss, the energy density of the foods they choose influences the amount of food they can eat to stay within their calorie goals. For weight loss, patients need to be encouraged to regularly make simple healthy shifts within their habitual eating pattern so that a reduction in dietary energy density leads to lower energy intake.^{35,36}

Practical Dietary Strategies for Weight Management

Research shows that a variety of eating patterns that include a reduction in energy intake can work for weight management, but patients may not know which foods to choose or nutrients to emphasize to build their own healthy pattern.⁸ In order to create a sustainable dietary pattern for weight loss, patients need to make changes that manage energy intake while receiving optimal nutrition, controlling hunger, and promoting satiety. This section will

discuss evidence-based strategies that individuals can use to lower dietary energy density, promote satiety, and meet nutrient recommendations.

Strategies to increase the proportion of low-energy-dense foods

Substitute lower-energy-dense foods for higher-energy-dense foods: In order to emphasize the importance of eating low-energy-dense foods, the Dietary Guidelines include MyPlate to communicate to the public (<https://www.choosemyplate.gov>).³⁷ MyPlate reminds people that half of their meal should be vegetables and fruits. An advantage to emphasizing the proportions of dietary components that comprise a healthy diet is that the message can be applied regardless of absolute energy needs.

But does such advice affect behavior? Numerous studies show that the portion of a food that is served affects intake, such that the bigger the portion, the greater the intake.^{4,38–41} Increasing the proportion, and thus the portion size, of vegetables and fruits can increase their intake, but it is important that they are relatively palatable compared to the other foods available.⁴² Thus, when advising patients to adopt MyPlate, they should be encouraged to find strategies to increase the palatability while not greatly increasing the energy density of the vegetables and fruits. The addition of herbs and spices, or the use of moderate amounts of healthy fats and sauces, can encourage vegetable consumption^{43,44} Providing a variety of vegetables has been shown to increase vegetable intake compared to just offering one.⁴⁵ While increasing the portion of vegetables at a meal can increase vegetable intake, it will not necessarily reduce energy intake. In order to decrease energy intake at the meal, larger portions of vegetables or fruits must be substituted for foods higher in energy density so that the overall energy density of the meal is lowered.⁴⁶ See Figure 3 for an example of how substituting lower-energy-dense foods for higher-energy-dense foods can create a more satisfying meal.

Decrease the energy density of the main course: Since the main course or entrée often contributes the most calories to a meal, a reduction in its energy density can significantly decrease energy intake at a meal. Importantly, studies show that lower-energy-dense entrées still satisfy hunger and do not lead to compensation by consuming more food later in the day.⁴⁷ Practical methods for modifying the energy density of an entrée include simple shifts such as reducing unhealthy fat and substituting water-rich ingredients such as fruits or vegetables for those higher in energy density.^{48–50} For individuals who do not particularly like vegetables, the covert incorporation of vegetables into meals has been shown to improve diet quality and manage energy intake.^{51,52}

Add a low-energy-dense first course: Another way to increase the proportion of low-energy-dense foods and reduce dietary energy density is through the addition of a low-energy-dense first course. “Filling up first” with a 100- to 150-calorie broth-based soup, leafy green salad, or whole fresh fruit before a meal is a simple strategy to lower intake of higher-energy-dense main dishes and decrease meal energy intake.^{38,53–57}

These strategies to increase consumption of low-energy-dense foods and reduce those higher in energy density are flexible; patients can choose which foods to substitute and how the

substitution will fit into their diet. They should be encouraged to try a number of strategies until they find an approach that they can sustain.

Strategies to enhance satiety and meet nutrient needs with a low-energy-dense eating pattern

Manage fat to lower energy density and moderate energy intake: For years, scientists thought reducing dietary fat was the key to weight management, but now evidence from multiple clinical trials shows that both low- and moderate-fat diets combined with an energy restriction can be used to achieve weight loss.^{14,15,58} The government guidelines recommend a range of fat intake (See Table 3) to meet daily energy requirements. The range allows individuals to make adjustments to fat intake in their dietary pattern based on food or cultural preferences in order to promote adherence.⁸ Recent studies show success at weight loss at both the high and low ends of government-recommended fat intakes.^{11,58}

While there is a range in the amount of fat that is recommended in an eating pattern for weight loss, consuming too much fat can lead to a higher-energy-dense diet and weight gain.⁷ Because of the high energy density of high-fat foods, their portion size needs to be moderated to stay within recommended energy intakes. Some methods for moderating fat intake at meals include switching to lower-fat alternatives such as grilled chicken instead of fried chicken or low-fat Greek yogurt instead of sour cream. Shifts should also be made to decrease the amount of solid fats, which contain saturated and trans fat, and to substitute with oils containing polyunsaturated and monounsaturated fats to improve diet quality and overall health.⁸ Patients should focus on using healthy fats in moderate amounts that improve their diet's palatability.

Include protein and fiber to create satisfying meals: Both protein and fiber have been suggested to promote satiety or feelings of fullness. Individuals are often reluctant to make changes to their dietary pattern because they do not want to feel hungry, and higher protein intakes are frequently recommended to help manage hunger and increase satiety.⁵⁹⁻⁶¹ Protein is described as the most satiating macronutrient, and multiple studies suggest that incorporating more protein can increase satiety and decrease daily energy intake.^{62,63} However, other laboratory-based studies have shown that when energy density is controlled, the amount of protein served during a meal had no influence on daily energy intake or satiety.⁶⁴ Research needs to continue to investigate the satiating properties of protein and to further evaluate the amounts and types of protein that show promise for body weight management.^{14,62,63,65,66} Patients should be encouraged to incorporate recommended amounts of lean protein sources such as grilled chicken breast, legumes, or low-fat dairy to create satisfying low-energy-dense meals.³⁴ Table 3 provides nutritional guidance on recommended amounts of protein and lean protein sources to include in a healthy eating pattern.

Dietary fiber is thought to promote feelings of fullness by increasing chewing time, promoting stomach expansion, and decreasing absorption efficiency.⁶⁷ Studies show that increasing fiber at meals can lead to decreased energy intake and increased ratings of fullness.^{68,69} Population-based studies suggest that diets containing higher amounts of fiber

are associated with lower body weights and reduced disease risks.⁷⁰ Some randomized controlled trials evaluating the addition of fiber-rich foods, such as legumes, have also found increased fiber to be beneficial for weight management.⁶⁸ Fiber is often found in foods low in energy density, such as fruits and vegetables, and choosing fiber-rich foods can help enhance satiety, improve overall health, and support weight management (See Table 3).^{34,70}

Manage added sugar intake and consider nonnutritive sweeteners: A goal to reduce consumption of foods and beverages containing added sugars should be a part of every weight loss program.³⁴ The main sources of added sugars are beverages (which will be discussed next), snacks, and sweets.⁸ Foods such as fruits, vegetables, and dairy products also contain sugar, but these items contain natural sugars, and the recommendations limit added sugars typically found in nutrient-poor, higher-energy-dense foods and beverages.^{8,71}

One option to help manage added sugar and energy intake is the use of nonnutritive sweeteners.^{71,72} While observational studies suggest a link between nonnutritive sweeteners and weight gain, randomized controlled trials have consistently found nonnutritive sweeteners to support weight loss.^{72,73} Multiple organizations support the use of nonnutritive sweeteners to help moderate energy intake when they are substituted for a higher-energy-dense food, like sugar.⁷¹

Choose water and other low-calorie beverages to satisfy thirst: Even though most beverages are low in energy density because of their high water content, added sugar or fat can quickly increase the number of calories a beverage contains. This means that patients should be encouraged to choose water and other low-calorie beverages in place of higher-calorie beverages. Beverages have been suggested to have low satiating properties, in that people do not reduce their food intake to compensate for calories in beverages.^{34,74,75} This reinforces the importance of messages to patients emphasizing that drinking caloric beverages can lead to increased energy intake.^{34,74} Eliminating or reducing caloric beverage consumption is a promising strategy for weight management; research suggests substituting water or diet beverages for caloric beverages can improve weight loss.^{72,73}

Beverages that individuals may be unwilling to eliminate from their dietary pattern are those containing alcohol. Alcoholic beverages can be included in moderation within recommended calorie limits.⁸ Individuals need to be aware that energy from alcohol is poorly compensated for, meaning that they are unlikely to eat less because alcohol has been consumed at a meal or snack. So if having an alcoholic drink, they should consume lower-energy-dense foods to help control energy intake.^{34,75,76} When consuming alcoholic beverages, patients should make sure the energy content fits within their own personal eating pattern for weight management.^{8,75,77}

Daily intake patterns that can help to lower dietary energy density

Breakfast: The pattern of food consumption over a day as either meals or snacks could affect weight management. Most members of the National Weight Control Registry, people who have lost thirty or more pounds and kept it off for at least a year, report eating breakfast every day as a strategy to help with maintenance of weight loss.⁷⁸ Epidemiological studies have also found breakfast consumption to be associated with lower body weights and lower

daily energy density.^{78–81} However, controlled intervention trials have not found that consistently eating breakfast leads to greater weight loss than skipping the meal.^{81,82} If individuals are habitual breakfast eaters, including higher amounts of protein and fiber during breakfast may help increase satiety, decrease energy intake, and lower dietary energy density.^{80,81}

Snacking: The definition of snacking varies, but it commonly refers to the consumption of foods and beverages between regular meals.⁸³ Research suggests that eating more than the standard three times per day has minimal influence on energy intake, but that eating less than three times per day may negatively influence energy regulation.⁸⁴ However, as the frequency of eating or snacking increases, the energy consumed from snacks high in energy density can also increase.⁸⁵ Patients should moderate their intake from medium- and high-energy-dense snacks, (like chips, pretzels, and confectionary) to keep snack intake under 200 calories per day and stay within energy needs.^{8,34} They should instead choose lower-energy-dense snacks so that they can have a larger, more satisfying portion for the same 200 calories, while also enhancing satiety and improving diet quality.⁸³ Evidence on the influence of snacking on body weight is mixed, but it does indicate that choosing low-energy-dense snacks, such as vegetables and fruits, helps moderate energy intake.^{83,86}

Tools to Achieve Healthy Dietary Patterns

Providing individuals with tools and resources for managing portion sizes can help them make sustainable changes to their dietary patterns. Tools can promote additional structure or provide visual cues to help individuals manage energy intake in the current obesogenic environment. This section will discuss current tools that patients can utilize to help support weight loss and weight loss maintenance.

Incorporate pre-portioned foods or meal replacements—The use of pre-portioned foods and meal replacements can help moderate intake by providing a structured meal plan with appropriate portion sizes.^{87,88} Pre-portioned foods include liquid meal replacements, single-serving snacks, and frozen entrées packaged and portioned for consumption at a single meal. A number of randomized controlled trials show that replacing one or two meals a day with liquid and solid pre-portioned foods can lead to substantial weight loss.^{87,88,90}

While pre-portioned foods and meal replacements have proven to be effective for weight loss, they have only recently been compared to other portion control strategies. The Portion Control Strategies Trial compared the effectiveness of three diet strategies (standard advice, portion selection, and pre-portioned foods) in a behavioral weight loss trial.⁹¹ The trial found that the pre-portioned foods group lost weight at a faster rate, but also regained weight at a greater rate compared to the other groups.⁹¹ Adherence to the pre-portioned foods strategy declined over time, possibly due to an increase in feelings of deprivation or to a decrease in the provision of vouchers for the pre-portioned foods.⁹¹ Further development is needed to determine the most effective strategies for incorporating pre-portioned foods in diets for weight management.

Include portion control tools—Portion control tools, such as plates, bowls, scales, serving spoons, measuring cups, and photographs, may help individuals to moderate energy intake by providing visual cues and teaching appropriate serving sizes.⁸⁷ The use of smaller dishware and utensils has been promoted; however, simply using smaller plates has not consistently been found to decrease energy intake and has not been tested for weight loss.^{92–94} Interventions have found that using plates designed to teach appropriate proportions to control energy intake (such as those based on MyPlate) promotes weight loss.^{95–97} The studies found that the portion-control plate groups achieved greater short-term weight loss at six months than the control groups.^{95–97} However, the studies reported poor compliance and high attrition rates, indicating that strategies are needed to maintain continued use of these portion-control tools.

Smartphone applications provide another tool that may help control energy intake by providing a platform for individuals to monitor their dietary intake.^{98,99} Self-monitoring helps individuals become aware of the foods and portion sizes they are consuming, and has been associated with increased and sustained weight loss.^{100–102} Digital photography can be used to help monitor intake by providing estimates of food portion sizes.^{103–105} However, using photographs with smartphone applications has limitations. It is difficult to measure and assess the energy density of the food in a photograph without knowing the recipes, and this limitation makes it challenging to estimate a patient's energy intake. Portion control tools using smartphone applications and photographs seem promising, but most are not evidenced-based, so they require further development in order to be improved for use in weight loss interventions.¹⁰⁶

Incorporate government recommended tools—A reduction in dietary energy intake is the foundation for all weight loss dietary patterns. Individuals are typically told to reduce energy intake by 30% or 500 to 750 calories per day.¹⁵ On average, this equates to women consuming between 1200 to 1500 calories per day and men consuming 1500 to 1800 calories per day.¹⁵ However, energy needs can vary widely based on body composition and physical activity level and must be reevaluated as weight is lost. To adjust for changing energy requirements, the National Institutes of Health has launched the Body Weight Planner based on mathematical models to create personalized energy prescriptions according to an individual's eating and exercise habits (Refer to Ch14 in this book).^{107,108} The Body Weight Planner can be used in combination with the U.S. Department of Agriculture's (USDA) Super Tracker and MyPlate to help individuals create personalized eating patterns and monitor food intake.¹⁰⁹

Future Directions

Over the past several decades, obesity research has debated what the optimal diet is for weight loss and weight maintenance. Emerging research indicates that diet recommendations should consider the variability that stems from individual characteristics.^{110,111} For example, individuals with high insulin secretion or high fasting plasma glucose may achieve greater weight loss on a diet with a low glycemic load compared to normoglycemic individuals.^{111–113} Future research should take a more personalized approach to determine how individuals' behaviors, genes, or metabolic profiles influence their weight.^{110–111} The

rapid advances in technology and biology will provide exciting new opportunities to collect information that will allow dietary patterns to be individually tailored for effective and sustainable weight loss.

Conclusions

Obesity is a multifactorial disease, with both individual and environmental factors influencing dietary adherence.^{114,115} Dietary approaches with a reduction in energy intake that have led to success at weight loss have focused on macronutrient composition and food patterns. A unifying principle for weight loss across eating patterns is dietary energy density.^{12,16,116–118} There are a variety of strategies and tools that individuals can use to achieve a personalized healthy eating pattern, and physicians or nutrition professionals can provide support and specific dietary advice on changes to improve an individual's eating behaviors.⁸ Table 3 provides a summary of nutritional goals and recommendations that can be used to help patients create sustainable and satisfying low-energy-dense eating patterns for weight loss.

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KEY POINTS

- Multiple dietary patterns are effective for weight management, with energy density as a unifying factor across patterns.
- There are a number of evidence-based strategies to lower energy intake, reduce dietary energy density, and improve diet quality that can be applied to individualized eating patterns for weight management.
- A variety of tools to help manage energy intake can be incorporated into personalized eating patterns to facilitate weight management.

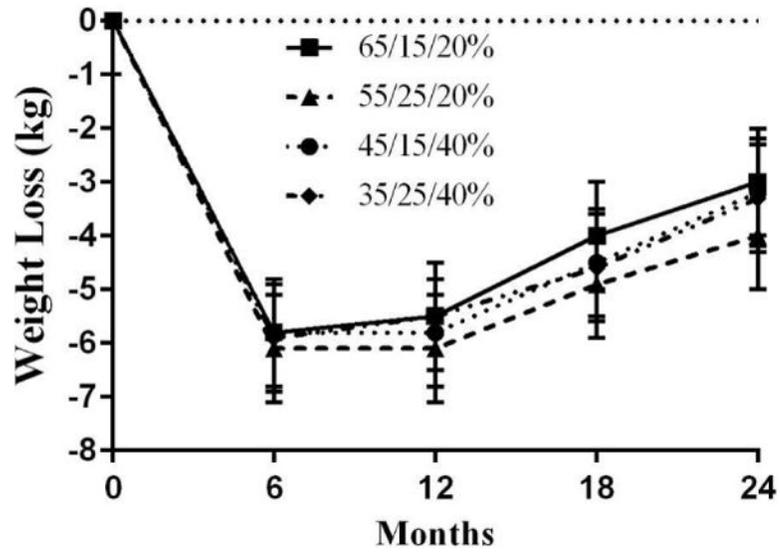


Figure 1. Weight loss over 2 years in adults assigned to 1 of 4 diets with different proportions of Carbohydrate/Protein/Fat as listed. There was no significant difference in weight loss related to the macronutrient composition.

Data from Sacks FM, Bray GA, Carey VJ, et al. Comparison of weight-loss diets with different compositions of fat, protein, and carbohydrates. *N Engl J Med* 2009; 360(9):859–873.



Figure 2.

The portion size of a 100-calorie snack varies depending on the energy density (ED) of the food. Jelly beans (ED 4.0 calories per gram) and raisins (ED 3.1 calories per gram) are high in energy density and provide small portions. Grapes (ED 0.69 kcal/g), apples (ED 0.53 kcal/g), and cherry tomatoes (ED 0.18 kcal/g) are lower in energy density and provide much bigger portions.

Courtesy of The Penn State Laboratory for the Study of Human Ingestive Behavior, University Park, PA.



Figure 3.

These three plates all contain steak, a baked potato with toppings, and vegetables. The plate on the far left contains 800 calories, which is almost half of a day's worth. However, if as shown in the middle picture, the portions of all foods are decreased to provide a 400-calorie meal, they do not appear very satisfying. The picture on the right also provides 400 calories but provides a more satisfying meal by increasing the portions of low-energy-dense foods, reducing the fat content, and moderating the protein portion.

Courtesy of The Penn State Laboratory for the Study of Human Ingestive Behavior, University Park, PA.

Table 1

Recommended daily amounts of food from each food group for the US Healthy Eating Pattern (DASH) and the Mediterranean Eating Pattern at two calorie levels

Food Group	Healthy US-Style Eating Pattern		Healthy Mediterranean-Style Eating Pattern	
	1400 calories	1800 calories	1400 calories	1800 calories
Vegetables ^a	1 ½ cups	2 ½ cups	1 ½ cups	2 ½ cups
Fruits ^b	1 ½ cups	1 ½ cups	1 ½ cups	2 cups
Grains ^c	5 oz	6 oz	5 oz	6 oz
Dairy ^d	2 ½ cups	3 cups	2 ½ cups	2 cups
Protein Foods ^e	4 oz	5 oz	4 oz	6 oz
Oils	17 g	24 g	17 g	24 g

^aAll fresh, frozen, and canned vegetables. Choose a variety, including dark green vegetables, red and orange vegetables, legumes, and starchy vegetables. A serving or 1 cup-equivalent for vegetables is: 1 cup raw or cooked vegetables, 1 cup vegetable juice, and 2 cups salad greens.

^bAll fresh, frozen, canned, and dried fruits and fruit juices. A serving or 1 cup-equivalent for fruits is: 1 cup raw or cooked fruit, 1 cup fruit juice, or ½ cup dried fruit.

^cChoose whole grains for at least half of the grain servings. A serving or 1 ounce-equivalent for grains is: ½ cup cooked grain, 1 medium slice of bread, or 1 cup of ready-to-eat-cereal.

^dIncludes all milk and fortified soy beverages, yogurt, frozen yogurt, dairy desserts, and cheeses. Most choices should be fat-free or low-fat. A serving or 1 cup-equivalent for dairy is: 1 cup of milk or yogurt or 1 ½ ounces of cheese.

^eAll seafood, meats, poultry, eggs, soy products, nuts, and seeds. Meats and poultry should be lean or low-fat. A serving or 1 ounce-equivalent of protein is: 1 ounce lean meat, poultry, or seafood, 1 egg, ¼ cup cooked beans or tofu, 1 tablespoon peanut butter, or ½ ounce nuts or seeds.

Adapted from U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015–2020 Dietary Guidelines for Americans, 8th Edition. 2015. Available at <http://health.gov/dietaryguidelines/2015/guidelines/>. Accessed Feb 11 2017.

Table 2

Energy density categories and examples of foods in each category

Energy Density Category	Energy Density Range (calories per gram)	How to Eat	Examples of Foods
Very Low Energy Density	0.0 to 0.6	“Free” foods to eat anytime	Most fruits and vegetables, broth-based soups, non-fat milk
Low Energy Density	0.6 to 1.5	Eat reasonable portions	Cooked grains, low-fat meats, beans and legumes, low-fat mixed dishes such as chili and pasta
Medium Energy Density	1.5 to 4.0	Manage portions	Meats, cheese, bread, snack foods such as popcorn and pretzels, mixed dishes such as pizza and macaroni & cheese
High Energy Density	4.0 to 9.0	Carefully manage portions and frequency of eating	Crackers, chips, cookies, nuts, butter, oils

Adapted from The ultimate volumetrics diet by Barbara Rolls, Ph.D. with Mindy Hermann, R.D. ©2012. Courtesy of Harper Collins Publishers.

Table 3

Summary of nutritional goals and practical dietary strategies for weight loss

Element	Nutritional Goal	Recommendation
Fat	20 to 35% of total calorie intake	Fat is high in energy density. Choose appropriate portions of healthy fats to improve diet quality and meet nutritional needs. <ul style="list-style-type: none"> • Substitute lower-fat foods for those higher in fat • Include monounsaturated and polyunsaturated fats
Protein	10 to 35 % of total calorie intake	Include protein to create satisfying meals and meet nutrient needs. <ul style="list-style-type: none"> • Include lean meats, poultry without skin, fish, eggs, legumes, tofu, and low-fat dairy products
Carbohydrate	45 to 65% of total calorie intake	Switch to whole grains instead of refined grains. <ul style="list-style-type: none"> • Examples include wheat, brown rice, oats, barley, corn
Fiber	20 to 35 grams per day	Include fiber to help increase satiety <ul style="list-style-type: none"> • Add legumes, fruits, vegetables, and whole grains
Added Sugar	Limit to less than 10% of total calorie intake	Limit foods and beverages containing added sugars. <ul style="list-style-type: none"> • Main sources of added sugars are snacks, sweets and beverages • Nonnutritive sweeteners can be a substitute
Beverages		Select low-calorie beverages. <ul style="list-style-type: none"> • Water is the best choice • Limit intake of alcoholic beverages
Dietary Strategy		Recommendation
Monitor portions		Choose appropriately sized portions to help meet daily energy requirements. <ul style="list-style-type: none"> • Serve large portions of very low- and low-energy-dense foods • Serve smaller, less frequent portions of medium energy-dense foods • Limit portions of high-energy-dense foods
Increase the proportion of lower-energy-dense foods		Lower-energy-dense foods provide satisfying portions to help increase satiety. <ul style="list-style-type: none"> • Fill half the plate with fruits and vegetables • Start the meal with a first course broth-based soup or salad • Substitute fruits and vegetables for higher-energy-dense ingredients