

Can eating fruits and vegetables help people to manage their weight?

Summary

Consuming a diet high in fruits and vegetables is associated with lower risks for numerous chronic diseases, including cancer and cardiovascular disease.^{1,2} Even so, the impact of eating fruits and vegetables on weight management has not been widely researched. This brief will examine the evidence from available studies to determine whether eating fruits and vegetables can help with weight management. We are providing only the outcomes of these studies, but we encourage you to read the articles themselves to gain many more insights into the health aspects of eating fruits and vegetables.

The research that we cover in this brief will support the conclusion that replacing foods of high energy density (high calories per weight of food) with foods of lower energy density, such as fruits and vegetables, can be an important part of a weight management strategy.

Extensive research has been conducted on the relationships between calories, amount of food eaten and body weight. The association of this information with the role of fruits and vegetables in weight management can be summarized as follows:

- ❖ To lose weight a person must eat fewer calories than what he or she expends.
- ❖ People may not limit what they consume based on calories alone. Feeling full is one reason that people stop eating. Short-term studies indicate that the volume of food people eat at a meal is what makes them feel full and stop eating, rather than the calorie content of the food.

- ❖ At the same calorie level, foods with low energy density provide a greater volume of food, which may help people feel full at a meal while consuming fewer calories.
- ❖ Water and fiber increase the volume of foods and reduce energy density. In their natural state, fruits and vegetables have high water and fiber content and thus are low in calories and energy density.
- ❖ Fruits and vegetables are good substitutes for foods of high energy density.

Research Review: Eating fruits and vegetables may help manage weight.

Losing weight can be very difficult, even for the highly motivated. In addition, maintaining an appropriate weight is difficult, particularly as a person ages. Health care professionals need to provide sound, scientific information when they advise people to eat foods that help them stay healthy, which includes maintaining a suitable weight. The research community is evaluating the effectiveness of a number of weight loss strategies; however, this brief examines only one strategy: the role that fruit and vegetable consumption may play in weight management.

Very few studies in the literature have investigated whether there is a direct relationship between eating fruits and vegetables and losing weight. The studies in this brief examined many issues such as the relationships of calories, volume of food eaten, types of food eaten (including fruits and vegetables), satiety, and weight reduction. Many of the studies reported on consumption of fruits and vegetables but did so in the context of a larger framework, such as preventing or treating high blood pressure or cardiac disease, but reported on weight loss also.

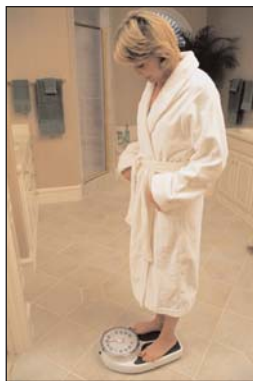


Research to Practice Series, No. 1

National Center for Chronic Disease Prevention and Health Promotion
Division of Nutrition and Physical Activity



Regardless of what types of food a person eats, the basic rule concerning weight loss is that to lose weight people must consume fewer calories than they expend. However, limitation of intake need not be based on calories. A feeling of being full is another reason that people stop eating.



People eat more food than they need for many reasons. The popular term "comfort food" succinctly provides one reason: people eat foods that make them feel good, that give them comfort. Some may eat to overcome fatigue; others may mistake thirst for hunger. This brief does not explore these issues, but instead looks at eating to the point of feeling full.

Energy Density

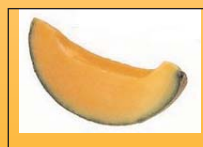
Energy density is the relationship of calories to the weight of food (calories per gram).



Foods high in energy density have a large number of calories relative to their weight or volume (4 to 9 calories per gram of weight). Foods high in energy density include low-moisture foods like crackers and cookies or high-fat foods like butter and bacon.



Foods with medium energy density range from 1.5 to 4 calories per gram of weight. Examples include hard-boiled eggs, dried fruits, bagels, broiled lean sirloin steak, hummus, grape jelly, whole wheat bread, and part-skim mozzarella.



Foods low in energy density have 0.7 to 1.5 calories per gram; those very low in energy density range from 0 to 0.6 calories per gram. Examples of foods in these two groups include tomatoes, cantaloupe, broth-based soups, fat free cottage cheese, fat free yogurt, strawberries, broccoli, and turkey breast roasted with no skin. Most fresh fruits and vegetables fall into one of these two categories.

Energy Density and Volume

Short-term studies (mostly conducted over several days with limited food options) described in the following section indicate that feeling full is more likely to make a person stop eating than is the total caloric content of the food consumed. Many people believe that consuming high-calorie foods will make them feel full, but a study by Duncan and colleagues³ provided contrary evidence. In their study 20 obese and nonobese participants ate as much as they wanted over 5 days from a diet that alternated from low-energy-density to high-energy-density foods. On the low-energy-density diet, the participants felt full with just over half the calories (1570 kcal) they needed to feel full on the high-energy-density diet (3000 kcal).

The positive effect of the volume of food eaten on the feeling of being full was demonstrated by researchers who created a greater volume of milkshakes simply by adding air. In a study published in 2000 by Rolls and colleagues,⁴ 28 men ate 3 meals in the laboratory 1 day a week for 4 weeks. On 3 of the 4 days the participants were given a yogurt-based milkshake 30 minutes before lunch. The milkshakes varied in volume (300 ml, 450 ml, and 600 ml) and were equal in caloric content because the higher volume was achieved by incorporating air. All three "sizes" had identical ingredients and weighed the same. Calories consumed were 12% lower following consumption of the 600 ml milkshake, and participants reported greater increases in feelings of fullness after drinking the 450 ml milkshake or the 600 ml milkshake than after the 300 ml drink.

For the same number of calories, people can eat foods with low energy density in greater volume than foods with high energy density. This helps people feel full and yet consume fewer calories.



In a study by Bell et al. (1998),⁵ 3 groups of women were provided meals and an evening snack for 2 days. One group followed a low-calorie menu; the second, a medium-calorie menu; and the third, high-calorie menu. The 3 menus were similar except that more vegetables were offered in the medium- and low-calorie menus to reduce their overall caloric content. The researchers found that women in each group ate a similar amount of food, which resulted in the medium-calorie group consuming more calories than the low-calorie group and the high-calorie group consuming more than either of the other 2 groups.

Another study⁶ shows how water added to food increases volume and thus its overall impact on feeling full. Twenty-four women ate breakfast, lunch, and dinner in the laboratory 1 day a week for 4 weeks. On 3 days of the 4 days, they were served a dish made of the same ingredients but prepared differently. On 1 day, they were served a chicken-rice casserole; the second, a chicken-rice casserole with a glass of water; on the third chicken-rice soup. The soup was made by adding the water into the casserole ingredients used the day before. Serving size was 1^{1/3} cups for the casserole and 2^{1/2} cups for the soup. Eating the soup significantly increased the feeling of fullness and reduced the participants' hunger, also significantly reducing the number of calories the women consumed during lunch. Drinking a glass of water with the casserole had no effect on total calories consumed or on feelings of being full.

Other studies have yielded similar findings. In a literature review by Yao and Roberts in 2001,⁷ the authors found in short-term studies that eating low-energy-dense foods promoted feelings of being full, reduced hunger, and decreased energy intake regardless of how the food was changed to lower the energy density (such as reducing fat). In the long-term studies they reviewed, eating low-energy-density foods promoted moderate weight loss. In studies lasting longer than 6 months, weight loss was 3 times greater in persons who ate foods of low energy density (low in fat and high in fiber) than in those who simply ate low-fat foods.

Water and fiber in foods increase volume and thereby reduce energy density. In their natural state, fruits and vegetables have high water and fiber content and are low in calories and energy density.



Fat increases the energy density of foods, while water and fiber decrease energy density. Water has the greatest impact on energy density because it adds weight to food without increasing calories, thus decreasing energy density.⁸ Most fruits and vegetables are low in energy density because of their high water and fiber content and their low fat content.

The water and fiber content of many vegetables and fruits is well documented. The USDA's Web site on food composition (www.nal.usda.gov/fnic/foodcomp) lists water, fiber, and many other food components (including calories) for hundreds of vegetables and fruits.

The few researchers who have studied the effects of water and fiber in foods have frequently conducted their studies

on different forms of fruits (e.g., whole, purée, and juice). The results indicate that fruits can enhance satiety, especially when consumed whole. Researchers in a study⁹ comparing different forms of apples, each containing 60 g of sugar, found that whole apples, which contained 2.9% fiber, were associated with higher satiety ratings than was apple purée or fiber-free apple juice. The authors attributed the differences in satiety to the fiber content of the foods and its effects on glucose homeostasis. Another study¹⁰ which compared whole oranges (2.5% fiber) to orange juice (fiber free) and whole grapes (1.3% fiber) to grape juice (fiber free) confirmed that whole fruit provided more satiety than juice. Instead of one serving of orange juice (6 ounces, 85 calories), a person can eat a medium orange and consume only 65 calories and obtain much more fiber and volume.

In studies that tested the influence of vegetables on feeling full,¹¹⁻¹⁴ Gustafsson and colleagues found that adding vegetables (carrots and spinach) to meals with equal calories enhanced the feelings of being full if at least 200 g of vegetable were added. These studies did not distinguish whether the effect was related to the vegetables' fiber and water content or the reduction of energy density of the food. However, the ratings of fullness were correlated positively with the dietary fiber content, the water content, and the total weight of the meal.

Dietary fiber, regardless of the source, has also been linked to weight regulation. A review summarizing the effects of high- versus low-fiber diet interventions found that the high-fiber diets in 20 of 22 studies resulted in weight loss.¹⁵ Using pooled data from 12 of the intervention studies that did not control energy intake, the authors found that the participants on the higher-fiber diets lost significantly more weight than those on the lower-fiber diets. From those same studies it was found that an increase of 14 g of fiber a day was associated with an average weight loss of 1.9 kg (4.2 lb) over 3.8 months. These analyses highlight the importance of fiber-rich foods, such as fruit and vegetables, in weight regulation.

Numerous foods are low in energy density. Among these foods, fruits and vegetables are excellent substitutes for high-energy-density foods.



Fruits and vegetables are good substitutes, in part

What is the difference between volume and amount?

In this brief, volume means the same thing as amount; both terms refer to the space occupied in three dimensions, or cubic size. They do not refer to weight.

because of their nutritional benefit, including their vitamins and minerals and because consuming them appears to be associated with decreased cancer and cardiovascular disease.^{1,2}

Dietary Interventions and Advice to Lose Weight

Although no studies have directly linked consumption of fruits and vegetables to weight loss, many studies have considered fruit and vegetable consumption in the management of chronic diseases while also reporting on weight loss and maintenance. Many of these studies are included in a recent comprehensive review of intervention studies.¹⁶ The review's authors concluded that significant weight loss can occur when advice to increase intake of fruits and vegetables is coupled with advice to reduce energy intake. Some of the studies reviewed are highlighted in the following text.

In the Multiple Risk Factor Intervention Trial (MRFIT),¹⁷ the participants were counseled to reduce fat and increase fruit and vegetable consumption to help lose weight and improve blood lipids and blood pressure. The recommendations emphasized fat reduction (to less than 35% of energy from fat), increased intake of fruits and vegetables (to 5 or more servings per day), and an increased consumption of grains. An increase in fruit and vegetable intake was related to maintenance of weight loss, and participants who lost more weight also showed a greater intake of fruits and vegetables. Participants made significant increases in their intakes of grains, fruits, and vegetables and decreased fat, all of which made an important contribution to weight loss.

In a study by Fitzwater et al.,¹⁸ 213 obese adults were encouraged to change their eating habits to an energy-restricted diet of low-fat, high-complex-carbohydrate foods emphasizing unlimited fruits and vegetables. Over the time period of the study, 147 (69%) of the participants were successful at losing weight, with the average loss of 6.3 kg (13.9 lb). Over an average of 25 months of follow-up (range 4 to 76 months), 53% of participants continued to lose or maintain their weight, and the mean net weight loss from the pretreatment to end of follow-up was 8.0 +/- 1.0 kg (17.6 ± 2.2 lb).

In a study published in 2001,¹⁹ Epstein and colleagues evaluated the effect of a parent-focused behavioral intervention on the eating habits of parents and children in families that had at least one obese parent and a nonobese child. The families were randomized to two groups. Parents in both groups were given a comprehensive behavioral weight-control program, but one group was encouraged to increase fruit and vegetable consumption, while the second group was urged to decrease the amount of high-fat and high-sugar foods. Materials for the children targeted the same dietary

changes as for their parents, but with no calorie restrictions. After 1 year, parents in the fruit and vegetable group had significantly greater decreases in weight than the parents in the decreased fat and sugar group. Furthermore, the parents and children in the increased fruit and vegetable group had decreased their consumption of high-fat and high-sugar foods.

A few intervention trials²⁰⁻²⁴ have included advice to increase consumption of fruits and vegetables with advice to reduce fat intake without having a specific weight loss component in the intervention. In a study by Rock et al.,²⁰ participants were counseled to consume a daily diet that included specific amounts of fruit, vegetable, and juice servings, as well as fiber, and had 15 to 20% of energy from fat. After 1 year, the intervention and control groups did not differ significantly in body mass index (BMI; weight in kg/height in m²). Combined data from the 2 groups indicated that 11% lost weight, 74% maintained weight, and 15% gained weight.

Multivariate analysis of the diets of the participants who lost weight showed that increases in energy-adjusted intakes of vegetables and dietary fiber but not fruit were associated with a decrease in BMI. A decrease in percent energy from fat was not, however, associated with a drop in BMI. This study is one of the few that reported the effects of fruit and vegetable intake on weight loss independent of other dietary factors.

One analysis²¹ of the Polyp Prevention Trial reported that participants significantly increased their intake of fruits and vegetables and decreased their intake of fat within the first year of the study, losing a significant amount of weight. Again, however, the intervention did not have a specific weight loss component. Finally, in a series of trials by Singh et al.,²²⁻²⁴ cardiac patients who were encouraged to change their diets by lowering fat intake and increasing fruits and vegetables lost a significant amount of weight during follow-up. In summary, these studies that focused on chronic disease outcomes and gave combined advice to increase fruits and vegetables and decrease dietary fat without explicitly advising weight loss often found participants either maintaining their body weight or spontaneously losing weight during follow-up.

Only a few epidemiologic studies have focused on the relationship between fruit and vegetable intake and weight management.²⁵⁻²⁷ In an examination of data from the

Do people feel satiated? satisfied? or just plain full?

Satiety is the state of feeling full physically. In this brief, we have used satiety and feeling full interchangeably. Being satisfied could also imply a psychological satisfaction that may go beyond feeling full physically. The studies we have covered did not measure satisfaction; and thus, we have not used that term.

Behavioral Risk Factor Surveillance System, Serdula and colleagues²⁵ found underweight women consumed more fruit and vegetables than normal-weight women (no difference was seen between normal-weight and overweight women). Among men no differences in fruit and vegetable consumption were seen by weight category. Using data from the Continuing Survey of Food Intakes by Individuals (CSFII), Lin and colleagues²⁶ found that obese men consumed significantly fewer vegetables and more white potatoes than men in lower BMI categories. Among women, however, vegetable or white potato consumption did not differ by BMI category. Both obese men and women consumed significantly less fruit than those in lower BMI categories. Finally, in the Cancer Prevention Study II, a cohort study, Kahn and colleagues reported an inverse association over 10 years between vegetable intake and both BMI and waist circumference among both men and women.²⁷ Multivariate analysis found a decrease of 0.12 BMI units and a decreased likelihood of gain in waist circumference associated with vegetable intake greater than 19 servings per week (2.7 servings per day) versus less than 19 servings per week. In summary, although few studies appear promising, more research is needed to delineate the relationship of fruit and vegetable intake and body weight within the context of epidemiologic studies.

What Does the Research Say About Practice?

The research reported in this brief covers many short-term studies and some long-term studies. In some, participants chose the food they ate from a variety of options and ate their meals in their homes or regular eating places; others were conducted in laboratories. It would be very helpful to have long-term studies that specifically test the hypothesis that consumption of fruits and vegetables can be a strategy for losing weight.

Although we lack direct evidence from clinical trials that consumption of fruits and vegetables promotes weight loss, we have indirect evidence that eating fruits and vegetables may be very helpful to people who want to lose or maintain weight, as fruits and vegetables are low in calories and fat as well as high in fiber and water content.

Practitioners who advise their patients or clients to substitute fruits and vegetables for foods of high energy density as part of a weight management strategy might consider including the information that follows. A brochure, "How to use fruits and vegetables to help manage your weight," has been developed in conjunction with this brief for practitioners to use with their patients and clients. The brochure gives practical tips on the following:

- ❖ To lose weight, people must eat fewer calories than they expend. Adding fruits and vegetables to an existing eating plan that supplies sufficient calories or has more calories than needed can cause the person to gain weight. Fruits and vegetables should be substituted for foods high in energy density.
- ❖ To lower the energy density of foods, such as soups, sandwiches, and casseroles, substitute fruits and vegetables for some of the ingredients that have higher energy density, such as high-fat meat, cheese, and pasta. For example, vegetables such as carrots, broccoli, mushrooms, and celery can be added to a chicken noodle casserole, thereby lowering the energy density of a fixed amount (e.g., 1 cup) of the altered dish in relation to 1 cup of the original casserole. Lettuce, tomatoes, onions, and other sliced vegetables can be added to sandwiches while decreasing the amount of high-fat meat or cheese. Many different vegetables can be added to pasta sauce.
- ❖ The way fruits and vegetables are prepared and consumed makes a big difference in their effect on weight. Techniques such as breading and frying, adding high-fat dressings and sauces, and as part of a high-calorie dessert greatly increase the calorie and fat content of the dish even if it includes fruits and vegetables.
- ❖ Whole fruit is lower in energy density and more satiating than fruit juices. Pulp-free fruit juices lose their fiber content in the process of juicing. For weight control purposes, the whole fruit contains added fiber that helps make one feel full.
- ❖ Are canned and frozen fruits and vegetables just as good as fresh? Frozen and canned fruits and vegetables are good options when fresh produce is not available. Consumers should be careful, however, to choose those without added sugar, syrup, cream sauces, or other ingredients that will increase calories, thereby raising the energy density. Additionally, consumers should be aware that frozen and canned fruits and vegetables sometimes contain added salt, which is not in fresh produce.
- ❖ Vegetables tend to be lower in calories than fruit; thus substituting more vegetables than fruit for foods of higher energy density can be helpful in a weight management plan. The Dietary Guidelines for Americans, 5th Edition (2000), published by the US Departments of Agriculture and Health and Human Services, recommends that people eat more servings of vegetables than fruits in a healthy eating plan. www.usda.gov/cnpp.

References

- ¹ Ness AR, Fowles JW. Fruit and vegetables and cardiovascular disease: a review. *Int J Epidemiol* 1997;26:1-13.
- ² Block G, Patterson B, Subar A. Fruit, vegetables, and cancer prevention: a review of the epidemiological evidence. *Nutr Cancer* 1992;18:1-29.
- ³ Duncan KH, Bacon JA, Weinsier RL. The effects of high and low energy density diets on satiety, energy intake, and eating time of obese and nonobese subjects. *Am J Clin Nutr* 1983;37:763-7.
- ⁴ Rolls BJ, Bell EA, Waugh BA. Increasing the volume of a food by incorporating air affects satiety in men. *Am J Clin Nutr* 2000;72:361-8.
- ⁵ Bell EA, Castellanos VH, Pelkman CL, Thorwart ML, Rolls BJ. Energy density of foods affects energy intake in normal-weight women. *Am J Clin Nutr* 1998;67:412-20.
- ⁶ Rolls BJ, Bell EA, Thorwart ML. Water incorporated into a food but not served with a food decreases energy intake in lean women. *Am J Clin Nutr* 1999;70:448-55.
- ⁷ Yao M, Roberts SB. Dietary energy density and weight regulation. *Nutr Rev* 2001;59:247-58.
- ⁸ Grunwald GK, Seagle HM, Peters JC, Hill JO. Quantifying and separating the effects of macronutrient composition and non-macronutrients on energy density. *Br J Nutr* 2001;86:265-76.
- ⁹ Haber GB, Heaton KW, Murphy D, Burroughs LF. Depletion and disruption of dietary fibre. Effects on satiety, plasma-glucose, and serum insulin. *Lancet* 1977;2:679-82.
- ¹⁰ Bolton RP, Heaton KW, Burroughs LF. The role of dietary fiber in satiety, glucose, and insulin: studies with fruit and fruit juice. *Am J Clin Nutr* 1981;34:211-7.
- ¹¹ Gustafsson K, Asp N-G, Hagander B, Nyman M. Effects of different vegetables in mixed meals on glucose homeostasis and satiety. *Eur J Clin Nutr* 1993;47:192-200.
- ¹² Gustafsson K, Asp N-G, Hagander B, Nyman M. Dose-response effects of boiled carrots and effects of carrots in lactic acid in mixed meals on glycaemic response and satiety. *Eur J Clin Nutr* 1994;48:386-96.
- ¹³ Gustafsson K, Asp N-G, Hagander B, Nyman M. Satiety effects of spinach in mixed meals: comparison with other vegetables. *Int J Food Sci Nutr* 1995;46:327-34.
- ¹⁴ Gustafsson K, Asp N-G, Hagander B, Nyman M, Schweizer T. Influence of processing and cooking of carrots in mixed meals on satiety, glucose and hormonal response. *Int J Food Sci Nutr* 1995;46:3-12.
- ¹⁵ Howarth NC, Saltzman E, Roberts SB. Dietary fiber and weight regulation. Energy density of foods affects energy intake across multiple levels of fat content in lean and obese women. *Am J Clin Nutr* 2001;73:1010-1018.
- ¹⁶ Rolls BJ, Ello-Martin JA, Tohill BC. What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutr Reviews* 2004;62:1-17.
- ¹⁷ Dolecek TA, Stamler J, Caggiula AW, et al. Methods of dietary and nutritional assessment and intervention and other methods in the Multiple Risk Factor Intervention Trial. *Am J Clin Nutr* 1997;65(suppl 1):196S-201S.
- ¹⁸ Fitzwater SL, Weinsier RL, Wooldridge NH, et al. Evaluation of long-term weight changes after a multidisciplinary weight control program. *J Am Diet Assoc* 1991;91:421-4.
- ¹⁹ Epstein LH, Gordy CC, Raynor HA, Beddome M, Kilanowski CK, Paluch R. Increasing fruit and vegetable intake and decreasing fat and sugar intake in families at risk for childhood obesity. *Obesity Res* 2001;9(3):171-8.
- ²⁰ Rock CL, Thomson C, Caan BJ, et al. Reduction in fat intake is not associated with weight loss in most women after breast cancer diagnosis: evidence from a randomized controlled trial. *Cancer* 2001;91:25-34.
- ²¹ Lanza E, Schatzkin A, Daston C, et al. Implementation of a 4-y, high-fiber, high-fruit-and-vegetable, low-fat dietary intervention: results of dietary changes in the Polyp Prevention Trial. *Am J Clin Nutr* 2001;74:387-401.
- ²² Singh RB, Rastogi S, Verma R, et al. Randomised controlled trial of cardioprotective diet in patients with recent acute myocardial infarction: results of a one year follow up. *Br Med J* 1992;304:1015-9.
- ²³ Singh RB, Rastogi S, Niaz MA, et al. Effect of fat-modified and fruit- and vegetable-enriched diets on blood lipids in the Indian Diet Heart Study. *Am J Cardiol* 1992;70:869-74.
- ²⁴ Singh RB, Dubnov G, Niaz MA, et al. Effect of an Indo-Mediterranean diet on progression of coronary artery disease in high risk patients (Indo-Mediterranean Diet Heart Study): a randomized single-blind trial. *Lancet* 2002;360:1455-61.
- ²⁵ Serdula MK, Byers T, Mokdad AH, et al. The association between fruit and vegetable intake and chronic disease risk factors. *Epidemiol* 1996;7(2):161-5.
- ²⁶ Lin BH, Morrison BM. Higher fruit consumption linked with lower body mass index. *Food Review* 2002;25(3):28-32.
- ²⁷ Kahn HS, Tatham LM, Rodriguez C, et al. Stable behaviors associated with adults' 10-year change in the body mass index and likelihood of gain at waist. *Am J Public Health* 1997;87:747-54.