DIETARY FIBER

Simple Steps for Managing Weight and Improving Health

Currently, an estimated 68% of the U.S. adult population is overweight or obese. Obesity can increase the risk of chronic diseases, such as metabolic syndrome, hypertension, cardiovascular disease and type 2 diabetes. Improvements in physical activity and diet can help manage these conditions. One dietary behavior, increased fiber intake, is associated with a reduced risk of inflammation, cardiovascular disease, diabetes, and obesity. Increased fiber also is associated with gastrointestinal health and enhanced immune function. These health and weight benefits are either directly or indirectly related to the effect fiber has on the maintenance of beneficial intestinal bacteria, stool bulk, total energy intake, dietary energy density, appetite and satiety, and overall dietary patterns.

HOW MUCH FIBER DO I NEED?

The current dietary fiber recommendations are based on a level of dietary fiber observed to protect against coronary heart disease. For adults, the adequate intake (Al) for fiber set in the Dietary Reference Intakes (DRI's) is 14 g/ 1,000 kcal per day or 25 g/day for women and 38 g/day for men. Unfortunately, the consumption of fiber is well below this recommendation, with usual intakes averaging from 15 to 16 g/day. Thus, inadequate intakes of fiber may be a contributing factor to obesity and many disease states.

WHAT IS FIBER? WHAT FOODS ARE GOOD SOURCES OF FIBER?

Fiber is a general term used to describe edible non-digestible carbohydrates. Examples include cellulose (the main structural component of plant cell walls), hemicellulose (surrounds cellulose in plant cell walls), beta-glucans (components of fungi, algae, barley, and oats). Pectins (a viscous fiber found in many fruits such as berries), psyllium (highly viscous fiber derived from psyllium husks), and resistant starch (incompletely digested starch found in plant cell walls). Dietary fiber is defined as plant carbohydrates and lignin (component of "woody" plant cell walls such as flaxseeds) that cannot be digested by human digestive enzymes. Functional fibers are those non-digestible carbohydrates that have been isolated, extracted, or manufactured and shown to have some beneficial physiological effect (e.g., fiber supplements such as Metamucal. Total dietary fiber is the sum of both dietary and functional fibers. These fibers, whether derived from food or a supplement, pass through the small intestine relatively unchanged into the colon, where much of their beneficial action occurs.

Fibers frequently are categorized by their characteristics or physiological function within the body. Historically, fibers have been classified by the amount of soluble or insoluble fibers they contain. Soluble fibers attract water and become viscous (e.g., more gelatinous) during cooking or digestion. Foods high in soluble fibers include oats, peas, beans, apples, citrus fruits, carrots, barley, and psyllium (a common fiber supplement). Insoluble fibers do not dissolve in water and are found primarily in whole-wheat flours, wheat bran, nuts, and vegetables. Some soluble fibers absorb water and become viscous in the intestine, which slows stomach emptying and, thus, reducing carbohydrate absorption and blunting the post meal glycemic response. These viscous soluble fibers also can physically trap cholesterol and bile acids in the gut and decrease their absorption, thus, contributing to the lowering of blood cholesterol. Insoluble fibers add bulk to stool and promote improved bowel function.

Second, fibers also can be classified based on their metabolic effects. The undigested carbohydrates (e.g., fibers) that reach the colon undergo various degrees of degradation or

fermentation by gut bacteria. Fibers with a higher degree of fermentation produce energy and other substances such as short-chain fatty acids (SCFA), which enhance microbial growth and gut health and improve immune function. Some SCFAs can be absorbed and transported to the liver, potentially lowering the synthesis of cholesterol by the liver. Conversely, non-fermentable fibers pass through the gut virtually unchanged and increase fecal volume (bulk), thus, improving bowel function and laxation, while also trapping toxins and eliminating them from the system.

Prebiotics, a specific fiber classification, have received attention for their reported health benefits. Although all prebiotics are fiber, not all fibers are prebiotics. To be considered a prebiotic, the fiber must resist absorption, be fermented by intestinal bacteria, and stimulate the growth of gut bacteria, which may improve overall health.

HOW DOES FIBER CONTRIBUTE TO WEIGHT LOSS OR LESS WEIGHT GAIN?

Dietary fiber can lower body weight and promote weight maintenance through a number of different potential mechanisms. Three of these mechanisms are discussed below.

1. *Greater satiety.* A high-fiber diet improves satiety *(e.g.,* feelings of satisfaction and fullness that cause us to stop eating) through a variety of ways, including those bulleted below:

- Lowering energy density of the diet *(e.g,* food with lower kilocalories per gram).
- Providing a larger volume of food without contributing additional calories *(e.g.,* high-fiber foods add bulk to a meal and increase the sense of fullness).
- Displacing or substituting a high-energy-dense food *(e.g.,* candy bar) for a lower-energy-dense food *(e.g.*, apple) as a snack.
- Expansion of fiber *in* the stomach and gut, sending signals to the brain that satiety has been achieved.
- Greater release of satiety signals from the gut to the brain.
- Increased chewing time *(e.g.*, eating *an* apple vs. drinking apple juice).
- Delayed gastric emptying and prolonged digestion time caused by the viscosity of the fiber.
- Fermentation of specific fibers (such as pectin and resistant starches) by gut bacteria to SCFAs (butyrate, acetate, and propionate) has been shown to activate gut satiety hormones, potentially reducing overall food intake.

2. *Altered fat oxidation and storage*. Fiber also may alter how the body oxidizes and uses fat. As a result of delaying gastric emptying, insulin secretion in response to a carbohydrate-containing meal is reduced and blood glucose is maintained within normal concentrations. This approach lessens the potential for glucose spikes and valleys and the need for the liver to remove glucose from the blood for fat synthesis or to release glucose to maintain blood concentrations. High insulin concentrations also inhibit hormone-sensitive lipase, the enzyme responsible for breaking down stored triglycerides. Thus, reducing blood glucose and insulin concentration could potentially reduce fat storage and favor fat oxidation.

3. *Impact of fiber on beneficial gut bacteria*. Emerging research suggests that gut microbes may be involved in regulating energy balance. Preliminary studies in mice show that lean mice have different gut bacteria than obese mice, suggesting that

bacteria population may influence how efficiently energy is absorbed, used, and stored. Although this research suggests that increasing beneficial gut bacteria may promote weight loss, more data are needed showing a direct causal relationship between fiber intake, gut microbes, and body weight in humans.

HOW MUCH FIBER IS REQUIRED FOR WEIGHT MANAGEMENT?

The amount of fiber needed for weight loss or weight maintenance has not been established clearly. A position paper of the Academy of Nutrition and Dietetics suggests that health and weight loss benefits occur with fiber intakes of 20 to 27 g/ day from whole foods or up to 20 g of fiber per day from supplements.

The type of dietary fiber most beneficial for weight loss or prevention of weight gain also has not been established clearly. Because high-fiber foods, such as whole fruit and vegetables, whole grains, and legumes, contain other beneficial compounds *(e.g.,* macronutrients and micronutrients, phytonutrients, water), it is difficult to separate out the specific effects of fiber. Fiber may have a synergistic effect with other compounds found in foods because high-fiber foods have been shown to affect weight management positively.

Further work is also needed to determine how liquid and solid forms of fiber-containing foods differ in impacting body weight and energy intake in the long-term. However, foods in their whole less-processed form (whole vs. pureed carrots, a whole apple compared with apple sauce or apple juice) appear to result in greater satiety. Thus, current research suggests that consuming high-fiber foods in their more intact forms may promote greater feelings of fullness, assisting in long-term weight control.

HOW CAN I INCREASE MY DIETARY FIBER INTAKE?

Whole fruits and vegetables, legumes, nuts, seeds, and whole grains are all high-fiber foods that can increase total dietary fiber intake (Table 3). Two dietary strategies can assist with increasing the intake of these foods. One approach is the DASH eating plan, which encourages high intakes of fruits and vegetables, whole-grain consumption, and incorporating legumes and healthy sources of fats, such as nuts. A second approach is to increase fiber intake by following a low-energy density eating plan. Energy density refers to the energy (kilocalories) in a specific amount (grams) of food. This approach emphasizes incorporating whole fruits and vegetables into meals and snacks, increasing high-fiber whole grains, and reducing saturated fat intake by selecting lean meats and dairy. Low-energy dense foods are high in water and fiber content and lower in fat; thus, the feeling of satiety is maintained because of the bulk of the food consumed . More recently, fiber is also being added to traditionally non-fiber containing foods, such as yogurt and refined grain products. Please contact us with any comments and questions.

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