Position of the American Dietetic Association: Health implications of dietary fiber

ABSTRACT

Dietary fiber consists of the structural and storage polysaccharides and lignin in plants that are not digested in the human stomach and small intestine. A wealth of information supports the American Dietetic Association position that the public should consume adequate amounts of dietary fiber from a variety of plant foods. Recommended intakes, 20-35 g/day for healthy adults and age plus 5 g/day for children, are not being met, because intakes of good sources of dietary fiber, fruits, vegetables, whole and high-fiber grain products, and legumes are low. Consumption of dietary fibers that are viscous lowers blood cholesterol levels and helps to normalize blood glucose and insulin levels, making these kinds of fibers part of the dietary plans to treat cardiovascular disease and type 2 diabetes. Fibers that are incompletely or slowly fermented by microflora in the large intestine promote normal laxation and are integral components of diet plans to treat constipation and prevent the development of diverticulosis and diverticulitis. A diet adequate in fiber-containing foods is also usually rich in micronutrients and nonnutritive ingredients that have additional health benefits. It is unclear why several recently published clinical trials with dietary fiber intervention failed to show a reduction in colon polyps. Nonetheless, a fiber-rich diet is associated with a lower risk of colon cancer. A fiber-rich meal is processed more slowly, which promotes earlier satiety, and is frequently less calorically dense and lower in fat and added sugars. All of these characteristics are features of a dietary pattern to treat and prevent obesity. Appropriate kinds and amounts of dietary fiber for the critically ill and the very old have not been clearly delineated; both may need nonfood sources of fiber. Many factors confound observations of gastrointestinal function in the critically ill, and the kinds of fiber that would promote normal small and large intestinal function are usually not in a form suitable for the critically ill. Maintenance of body weight in the inactive older adult is accomplished in part by decreasing food intake. Even with a fiber-rich diet, a supplement may be needed to bring fiber intakes into a range adequate to prevent constipation. By increasing variety in the daily food pattern, the dietetics professional can help most healthy children and adults achieve adequate dietary fiber intakes.

INTRODUCTION

Dietary fiber has demonstrated benefits for health maintenance and disease prevention and as a component of medical nutrition therapy. Except in certain therapeutic situations, dietary fiber should be obtained through consumption of foods. In addition to fiber, minimally processed fruits, vegetables, legumes, and whole and high-fiber grain products provide micronutrients and nonnutritive ingredients that are essential components of healthful diets. Plant foods also may contain other nonnutritive components (eg, antioxidants, phytoestrogens) that have implications for health. A fiber-rich diet is lower in energy density, often has a lower fat content, is larger in volume, and is richer in micronutrients, all of which have beneficial health effects. By encouraging people to eat fiber-rich plant foods, the dietetics professional can have a significant impact on the prevention and treatment of obesity, cardiovascular disease, and type 2 diabetes, as well as constipation.

POSITION STATEMENT

It is the position of the American Dietetic Association (ADA) that the public should consume adequate amounts of dietary fiber from a variety of plant foods.

DIETARY FIBER

Recommended Fiber Intakes Through the Life Cycle

Recommendations for adult dietary fiber intake generally fall in the range of 20 to 35 g/day (1). Others have recommended dietary fiber intakes based on energy intake, 10 to 13 g of dietary fiber per 1000 kcal. Nutrition facts labels use 25 g dietary fiber per day for a 2,000 kcal/day diet or 30 g/day for a 2,500 kcal/day diet as goals for American intake. Attempts have been made to define recommended dietary fiber intakes for children and adolescents. Although based on limited clinical data, the recommendation for children older than 2 years is to increase dietary fiber intake to an amount equal to or greater than their age plus 5 g/day and to achieve intakes of 25 to 35 g/day after age 20 years (2). No published studies have defined desirable fiber intakes for infants and children younger than 2 years. Until there is more information about the effects of dietary fiber in the very young, a rational approach would be to introduce a variety of fruits, vegetables, and easily digested cereals as solid foods are brought into the diet. Specific recommendations for the elderly have not been published, although a safe recommendation would encourage intakes of 10 to 13 g dietary fiber per 1,000 kcal. All recommendations need to recognize the importance of adequate fluid intake, and caution should be used when recommending fiber to those with gastrointestinal diseases, including constipation.

Dietary fiber intake continues to be at less than recommended levels in the United States with usual intakes averaging only 14 to 15 g/day (3). When asked about their perceptions of their dietary fiber intake, 73% of individuals with a mean fiber intake below 20 g/day think the amount of fiber they consume is "about right" (3). Many popular American foods contain little dietary fiber. Servings of commonly consumed grains, fruits, and vegetables contain only 1 to 3 g of dietary fiber (4). Legumes and high-fiber bread and cereal products supply more dietary fiber, but are not commonly consumed.

Definition and Sources of Fiber

A variety of definitions of dietary fiber exist globally (5). Some are based primarily upon analytical methods used to isolate and quantify dietary fiber, whereas others are physiologically based. Dietary fiber is primarily the storage and cell wall polysaccharides of plants that cannot be hydrolyzed by human digestive enzymes. Lignin, which is a complex molecule of polyphenylpropane units and present only in small amounts in the human diet, is also usually included as a component of dietary fiber (5). For labeling the dietary fiber content of food products within the United States, dietary fiber is defined as the material isolated by analytical methods approved by the Association of Official Analytical Chemists (5). A variety of low-molecular carbohydrates that are being developed and increasingly used in food processing are not digested by human digestive enzymes (sugar alcohols such as sorbitol and mannitol, polydextroses, and various fructo- and galactooligosaccharides). These small polymers and oligosaccharides are not measured by the AOAC-approved methods for measuring dietary fiber, but methods specific for each material are being approved by AOAC to measure for these compounds (5).

Resistant starch (the sum of starch and starch-degradation products not digested in the small intestine) (6) contributes to the pool of microbial substrate or dietary fiber reaching the large intestine. Legumes are a primary source of resistant starch, with as much as 35% of legume starch escaping digestion (7). Small amounts of resistant starch are produced by the processing and baking of cereal and grain products. The amount of resistant starch in a typical Western diet is not known and meaningful tables of the resistant starch content of foods are not available.

Because of the availability of new manufactured materials that behave like dietary fiber, either analytically or physiologically, and the globalization of food markets, there is renewed interest in having a single, physiologically founded definition of dietary fiber. Two are receiving attention in North America. The definition developed by the American Association of Cereal Chemists is: "Dietary fiber is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plants substances. Dietary fibers promote beneficial physiological effects including laxation, and/or blood cholesterol attenuation, and/or blood glucose attenuation" (8).

The other definition for North America has been proposed by a panel assembled by the Food and Nutrition Board (5) as part of the federally mandated evaluation of Dietary Reference Intakes. The Panel on the Definition of Dietary Fiber proposed two new definitions: "Dietary Fiber" and "Added Fiber." Dietary Fiber consists of nondigestible carbohydrates and lignin that are intrinsic and intact in plants. Added Fiber consists of isolated, nondigestible carbohydrates that have beneficial physiological effects in humans. "Total Fiber" is the sum of Dietary Fiber and Added Fiber. The intent of these proposed definitions is to recognize the physiological actions of fiber and its demonstrable health effects, and to reduce the emphasis on dietary fiber as a constituent of food requiring quantification (5).

Benefits of Adequate Fiber Intake

Dietary fiber and blood cholesterol levels Several dietary fiber sources lower blood cholesterol levels, specifically that fraction transported by low density lipoproteins (LDL) (9). Fibers that lower blood cholesterol levels include foods such as apples, barley, beans and other legumes, fruits and vegetables, oatmeal, oat bran and rice hulls; and purified sources such as beet fiber, guar gum, karaya gum, konjac mannan, locust bean gum, pectin, psyllium seed husk, soy polysaccharide and xanthan gum (9). Two of these fibers, namely beta glucan in oats and psyllium husk, have been sufficiently studied for the FDA to authorize a health claim that foods meeting specific compositional requirements and containing 0.75 g or 1.7 g of soluble fiber per serving, respectively, can reduce the risk of heart disease (10). Consequently, these two dietary fibers are specifically included in the most recent National Cholesterol Education Program American Heart Association guidelines (11).

The mechanism by which these fiber sources lower blood cholesterol levels has been the focus of many investigations, and characteristics such as solubility in water, viscosity, fermentability, and the kinds and amounts of protein and tocotrienols have been explored as possible bases for this physiological effect (12). The one characteristic common to all cholesterol-lowering fibers is viscosity (12). Indeed, when a soluble fiber that is not viscous is evaluated or the fiber is treated to reduce viscosity sufficiently, the cholesterol-lowering ability is lost (13-15). As components in foods are digested and absorbed from the small intestine, fiber becomes a major component in the gut lumen, making the viscosity evident. This viscosity interferes with bile acid absorption from the ileum (16-17). In response, LDL cholesterol is removed from the blood and converted into bile acids by the liver to replace the bile acids lost in the stool. Some evidence also indicates that changes in the composition of the bile acid pool accompanying ingestion of some viscous fibers dampen cholesterol synthesis (17-18). Because endogenous synthesis accounts for about three-quarters of total body cholesterol pool, slowing synthesis, as do the "statin" drugs, could have a favorable impact on blood cholesterol concentrations. Increasing soluble fiber intake by consuming a wide variety of foods may (19) or may not (20) have a hypocholesterolemic effect; this variable effectiveness may depend on the composition of the rest of the diet.

Dietary fiber and normal laxation Many fiber sources, including cereal brans, psyllium seed husk, methylcellulose, and a mixed high-fiber diet increase stool weight, thereby

Table
Dietary fiber content of foods (g/serving)

Food Groups	Food	Serving Size	Total Dietary Fiber
Fruits	Apple, large w/skin	1 apple	3.7
	Banana	1 banana	2.8
	Figs, dried	2 figs	4.6
	Orange	1 orange	3.1
	Peach, canned	1/2	1.3
	Pear	1 pear	4.0
	Prunes, dried	5	3.0
	Raisins	1 miniature box (14 g)	0.6
	Strawberries, raw	1 cup, sliced	3.8
Vegetables	Beans, kidney, canned	1/2 cup	4.5
	Broccoli, raw	1/2 cup	1.3
	Brussels sprouts, cooked	1/2 cup	2.0
	Carrots, raw	1/2 cup	1.8
	Celery, raw	1/2 cup	1.0
	Lentils, cooked	1/2 cup	7.8
	Lettuce, iceberg	1 cup, shredded	0.8
	Peas, green, canned	1/2 cup	3.5
	Peas, split, cooked	1/2 cup	8.1
	Potatoes, boiled	1/2 cup	1.6
	Spinach, cooked	1/2 cup	2.2
Grains	Bread, white, wheat	1 slice	0.6
	Bread, whole wheat	1 slice	1.9
	Cheerios	1 cup	2.6
	Crackers, graham	2 squares	0.4
	Cream of Wheat	1 cup	2.9
	Oat bran muffin	1 muffin	2.6
	Oatmeal, cooked	3/4 cup	3.0
	Raisin bran	1 cup	7.5
	Rice, brown, cooked	1 cup	3.5
	Rye crispbread	1 wafer	1.7
	Shredded wheat	2 biscuits	5.0
	Wheat bran flakes	3/4 cup	4.6
Other	Apple pie	1 piece	1.9
	Chocolate cake	1 slice	1.8
	Mr. Goodbar	1 bar	1.7
	Nuts, mixed, dry roast	1 oz	2.6
	Yellow cake	1 slice	0.2

Source: USDA Nutrient Database for Standard Reference, Release 14

promoting normal laxation (21). Stool weight continues to increase as fiber intake increases (20-22), but the added fiber tends to normalize defecation frequency to one bowel movement daily and gastrointestinal transit time to 2 to 4 days (23). The increase in stool weight is caused by the presence of the fiber, by the water that the fiber holds and by partial fermentation of the fiber, which increases the amount of bacteria in stool (24-25). If the fiber is fully and rapidly fermented in the large bowel, as are most soluble fiber sources, there is no increase in stool weight (21). It is a common but erroneous belief that the increased weight is due primarily to water. The moisture content of human stool is 70% to 75% and this does not change when more fiber is consumed (26). In other words, fiber in the colon is not more effective at holding water in the lumen than the other components of stool. The one known exception is psyllium seed husk which does increase the concentration of stool water, to approximately 80% (27).

Dietary fiber, digestion, and satiety While emphasis has been placed on specific effects that can be detected as statistically significant when a particular fiber source is consumed, dietary fiber has many subtle, less easily quantifiable effects that are beneficial. This is particularly true for fiber provided by foods. A fiber-rich meal is processed more slowly, and nutrient absorption occurs over a greater time period (28). Further, a diet of foods providing adequate fiber is usually less energy dense and larger in volume than a low fiber diet which may limit spontaneous intake of energy (29). This larger mass of food takes longer to eat and its presence in the stomach may bring a feeling of satiety sooner, although this feeling of fullness is short term. A diet of a wide variety of fiber-containing foods also is usually richer in micronutrients.

When viscous fibers are isolated and thereby concentrated, their effects on digestion are frequently easier to detect; when these types of fibers are added to a diet, the rate of glucose appearance in the blood is slowed, and insulin secretion is subsequently reduced (30,31). These beneficial effects on blood glucose and insulin concentrations are most evident in individuals with diabetes mellitus. In healthy individuals, the rapid insulin secretion that causes rapid removal of glucose from the blood frequently makes it impossible to detect a difference between blood glucose concentrations during a test meal with and without a fiber supplement.

Other roles in health There is observational evidence that fiber may protect against duodenal ulcers (32) and cancer in the gastric cardia region (33). Animal experiments suggest that the type and amount of fiber consumed may affect intestinal immune function (34,35) but human studies are lacking. As a result of fiber serving as a substrate for bacteria in the large bowel, changes in intestinal bacterial populations, especially with the consumption of large amounts of purified, homogenous fibers (eg, fructooligosaccharides, arabinogalactans) have been reported (36). Some human data suggest that fructooligosaccharides may increase calcium absorption (37,38).

Soluble versus insoluble dietary fiber There has been a trend to assign specific physiological effects either to soluble or insoluble fibers. This approach makes it difficult to evaluate the effects of fiber provided by mixed diets. Dietary fiber provided by mixed diets is two-thirds to three-quarters insoluble, although the exact distribution between soluble and insoluble is very dependent on the method of analysis (39). Further, some fibers are placed in one category or another, when in fact, they may have major benefits attributable to both soluble and insoluble fibers; psyllium seed husk, oats, and oat bran are examples. Both of these fiber sources increase stool weight and improve laxation, as well as lower blood cholesterol levels (16,17,40,41). It is also apparent that all soluble fibers are not hypocholesterolemic agents, but rather, only those that are viscous. The disparities between the amounts of soluble and insoluble fiber that are measured chemically and their physiological effects has led a National Academy of Sciences Panel to recommend that the terms "soluble fibers" and "insoluble fibers" gradually be eliminated and replaced by specific beneficial physiological effects of a fiber (5).

Other components in fiber-containing foods There is substantial scientific evidence suggesting that vegetables, fruits, and whole grains reduce risk of chronic diseases, including cancer and heart disease (42-43). In epidemiologic studies, it is often easier to count servings of whole foods than translate information on food frequency questionnaires to nutrient intakes. Additionally, recent studies suggest that whole foods offer more protection against chronic diseases than dietary fiber, antioxidants, or other biologically active components in foods. Thus, associations between dietary fiber and disease identified through epidemiologic studies may actually be reflections of a synergy among dietary fiber and these associate substances, or of an effect of only the associated materials. This suggests that the addition of purified dietary fiber to foodstuffs is less likely to be beneficial, as opposed to changing American diets to include whole foods high in dietary fiber. The concept of synergy among components in whole foods and the attendant overall healthfulness of a varied diet are important aspects of any dietary counseling.

Disease Risk Reduction and Therapeutic Uses of Fiber

A lot of what is known about the benefits of a higher fiber diet comes from epidemiological studies. Sometimes there are disparities between epidemiological and metabolic studies. One possible source of discrepancy is the time of collection of diet information since the food supply and food habits change continuously, especially in response to the National Labeling and Education Act. Foods in current databases may not be reflective of what was consumed more than a decade ago; this is particularly true for data for dietary fiber in foods that have been gathered largely in the past 15 years. Fortunately, there are now fewer differences among methods of determination of total dietary fiber in US foods so that current fiber databases are improved over those that were available previously and are reasonably useful for epidemiological diet studies now.

In contrast, the division of total fiber between soluble and insoluble remains very method dependent. The proportion of the total fiber that is soluble varies by two- to threefold across major methods of analysis, meaning that there is the same extent of variation among the values for insoluble fiber (39). Thus, the use of databases to differentiate the effects of soluble versus insoluble fiber with disease could produce statistically significant relationships, particularly when values from one decade of time are applied to intake data collected during a different decade. Finally, people eat diets, and it is possible that the use of isolated, frequently single-fiber sources in metabolic studies is not representative of a mixed, high-fiber diet.

Prevention and management of diabetes mellitus Considerable experimental evidence demonstrates that the addition of viscous dietary fibers slows gastric emptying rates, digestion, and the absorption of glucose to benefit immediate postprandial glucose metabolism (44) and long-term glucose control (45,46) in individuals with diabetes mellitus. The long- term ingestion of 50 g of dietary fiber per day for 24 weeks significantly improved glycemic control and reduced the number of hypoglycemic events in individuals with type 1 diabetes (47,48). Among pregnant women with type 1 diabetes mellitus, a higher fiber intake was associated with lower daily insulin requirements (49). Studies with individuals with type 2 (non-insulin-dependent diabetes) suggest that high fiber intakes diminish insulin demand (50,51). Two cohort studies found that fiber from cereals, but not from fruits and vegetables, had an inverse independent relationship with risk of noninsulin-dependent diabetes (52,53).

The mechanisms whereby fiber may affect insulin requirements or insulin sensitivity are not clear. In rats and dogs, higher fiber intakes, especially of fermentable fibers, increases expression of the gut-derived proglucagon gene and secretion of proglucagon-derived peptides, including glucagon-like peptide-1 (GLP-1) (54,55). GLP-1 has been shown to reduce gastric emptying rates, promote glucose uptake and disposal in peripheral tissues, enhance insulin-dependent glucose disposal, inhibit glucagon secretion, and reduce hepatic glucose output in animals and humans (56). The multiple effects of GLP-1 may reduce the amount of exogenous insulin required by individuals with impaired glucose metabolism when consuming a high-fiber diet.

Prevention and management of cardiovascular disease The primary benefit of including dietary fiber as part of the medical nutrition therapy to treat cardiovascular disease is a consequence of fiber's effects on blood cholesterol levels. Thus, hypocholesterolemic fibers are those that are viscous. The secondary benefits of a higher fiber diet to treat cardiovascular disease may include lower energy, fat, and simple sugar contents, all of which would be effective treatments for the obesity and hypertriglyceridemia also associated with cardiovascular disease. Antioxidants found in some cereal brans and associated germ also may have health benefits.

Prevention and management of constipation The mechanisms by which dietary fiber promotes normal laxation are the bases for recommending fiber to treat and prevent constipation. The large intestine responds to the larger and softer mass of residue produced by a higher fiber diet by contracting, which moves the contents towards excretion. Fiber in mixed diets, legumes, and whole- and high-fiber grain products are particularly effective promoters of normal laxation. A fiber supplement may be needed when food intake is low, as is the case among inactive elderly; one of the cereal brans, psyllium seed husk, or methylcellulose is frequently used in these cases.

Prevention and management of diverticulosis Movement of material through the colon is stimulated in part by the presence of residue in the lumen. When chronic insufficient bulk accompanying a low-fiber diet occurs in the colon, the colon responds with stronger contractions in order to propel the smaller mass distally. This chronic increased force leads to the creation of diverticula, which are herneations of the mucosal layer through weak regions (around blood vessels) in the colon musculature. Adequate intake of dietary fiber prevents the formation of diverticula by providing adequate bulk in the colon so that less forceful contractions are needed to propel it distally. A high-fiber diet is standard therapy for diverticular disease of the colon. Formed diverticula will not be resolved by a diet adequate in fiber, but the bulk provided by such a diet will prevent the formation of additional diverticula, lower the pressure in the lumen, and reduce the chances that one of the existing diverticula will burst or become inflamed. Generally, small seeds or husks that may not be fully digested in the upper gastrointestinal tract are eliminated from a high-fiber diet for a patient with diverticulosis as a precaution against having these small pieces of residue become lodged within a diverticulum.

Relationship between dietary fiber and cancer

Large bowel cancer Extensive epidemiologic evidence supports the theory that dietary fiber may protect against large bowel cancer. Correlation studies that compare colorectal cancer incidence or mortality rates among countries with estimates of national dietary fiber consumption suggest that fiber in the diet may protect against colon cancer. Data collected from 20 populations in 12 countries showed that average stool weight varied from 72 to 470 g/day and was inversely related to colon cancer risk (57). When results of 13 case-control studies of colorectal cancer rates and dietary practices were pooled, the authors concluded that the results provided substantive evidence that consumption of fiber-rich foods is inversely related to risks of both colon and rectal cancers (58). The authors estimated that the risk of colorectal cancer in the US population could be reduced by about 31% with an average increase in fiber intake from food sources of about 13 g/day.

Three intervention studies do not support the protective properties of dietary fiber against colon cancer (59-61). The studies found no significant effect of high fiber intakes on the recurrence of colorectal adenomas. Each paper describes a well-planned dietary intervention to determine whether high fiber food consumption could lower colorectal cancer risk, as measured by a change in colorectal adenomas, a precursor of most large-bowel cancers. Several reasons have been given for the failure to demonstrate a benefit. Perhaps the fiber interventions were not long enough, the fiber dose was not high enough, the recurrence of adenoma is not an appropriate measure of fiber's effectiveness in preventing colon cancer, or these individuals had already optimized their diets since the fiber intake by the low fiber control subjects exceeded that of the American population (59,60). Yet the results from the studies are clear. Increasing dietary fiber consumption over 3 years did not alter the recurrence of adenomas. Despite the inconsistency in the results of fiber and colon cancer studies, the scientific consensus is that there is enough evidence that dietary fiber protects against colon cancer that health professionals should be promoting increased consumption of dietary fiber (62).

Breast cancer Limited epidemiologic evidence has been published on fiber intake and human breast cancer risk. Since the fat and fiber contents of the diet are generally inversely related, it is difficult to separate the independent effects of these nutrients, and most research has focused on the fat and breast cancer hypothesis. International comparisons show an inverse correlation between breast cancer death rates and the consumption of fiber-rich foods (63). An interesting exception to the high-fat diet hypothesis in breast cancer was observed in Finland, where intake of both fat and fiber is high, and the breast cancer mortality rate is considerably lower than in the United States and other Western countries where the typical diet is high in fat (64). The large amount of fiber in the rural Finnish diet may modify the breast cancer risk associated with a high-fat diet.

A pooled analysis of 12 case-control studies of dietary factors and risk of breast cancer found that high dietary fiber intake was associated with reduced risk of breast cancer (65). Dietary fiber intake also has been linked to lower risk of benign proliferative epithelial disorders of the breast (66). Not all studies find a relationship between dietary fiber intake and breast cancer incidence, including a US prospective cohort study (67). A pooled analysis of eight prospective cohort studies of breast cancer found that fruit and vegetable consumption during adulthood was not significantly associated with reduced breast cancer risk (68). A large case-control study reported protective effects with high intake of cereals and grains, vegetables, and beans (69).

Role of fiber in critical illness and use in enteral formulas No recommendations exist for fiber intake in several disease states or for patients in long-term care facilities. Two types of enteral formulas that contain dietary fiber are currently marketed: blenderized formulas made from whole foods and formulas supplemented with purified fiber sources. Purified fiber sources used in enteral products include oat, pea, hydrolyzed guar gum, and sugar beet fibers, as well as others.

Some formulas use a mixture of fiber sources. A recent addition to enteral formulas is fructooligosaccharides (FOSs), which are short-chain oligosaccharides (usually 2 to 10 monosaccharide units) that are not digested in the upper digestive tract and therefore have some of the same physiologic effects as soluble fiber (36). FOSs are rapidly fermented by intestinal bacteria that produce short-chain fatty acids (SCFA) which stimulate water and electrolyte absorption and should aid in the treatment of diarrhea. FOSs are a preferred substrate for bifidobacteria but are not used by potentially pathogenic bacteria, thus helping to maintain and restore the balance of healthy gut flora; and they are not isolated by the currently accepted method for dietary fiber so they cannot technically be called dietary fiber (5). The newly proposed definitions of dietary fiber, if implemented, should allow a label claim for FOSs as an added fiber (5).

The original rationale for adding dietary fiber to enteral formulas was to normalize bowel function. Dietary fiber is usually promoted as a preventive against constipation for the normal healthy population. Enteral formulas containing fiber are also used in the acute-care setting to prevent diarrhea associated with tube feeding. Bowel function is affected by more than fiber level, and there is much individual variation in the amount of fiber needed for optimal bowel function. Studies on the biologic effects of enteral formulas containing fiber are few, and even less information is available from patients. The addition of soy polysaccharide to an enteral formula significantly increased stool weights of healthy male adults (70), whereas no differences in stool weight or stool frequency were observed in one study when soy polysaccharide was added to the enteral formula of patients in a long-term care facility (71). However, in another study of the same population that was one year in length, soy polysaccharide fiber did significantly increase daily stool frequency, weight, and moisture (72). Thus, existing clinical studies do not uniformly support the assertion that the addition of dietary fiber to an enteral formula improves bowel function.

Dietary fiber is thought to normalize bowel function in healthy subjects, and there is anecdotal evidence of reduction of diarrhea in patients receiving fiber-containing formulas. No convincing data have been published to document that fiber-containing enteral formulas prevent diarrhea in tube-fed patients (73). Unfortunately, there are no standard, accepted ways of defining diarrhea. The reported incidence of diarrhea in tube-fed patients ranges from 2% to 63%. Stool frequency, stool consistency, and stool quantity are the three features of bowel elimination usually used to define diarrhea. In addition to fiber, oral agents such as sorbitol and magnesium have been suggested as important intake variables affecting stool consistency. Dietary fiber may improve fecal incontinence. Patients with fecal incontinence who consumed dietary fiber as psyllium or gum arabic had significantly fewer incontinent stools than with placebo treatment (74). Improvements in fecal incontinence or stool consistency did not appear to be related to unfermented dietary fiber.

The results of some clinical studies with dietary fiber have been disappointing, although the model proposed, that fiber is fermented by anaerobic intestinal bacteria that generate SCFAs, which serve as energy sources for colonic mucosal cells, is probably correct (75). To study the physiologic effects of dietary fiber, especially in a sick population, is extremely difficult. Most studies have been too short, measurements are semi-quantitative, and dietary fiber and SCFA levels were frequently not measured. It is not clear that results from in vitro fermentation studies have direct application in vivo. Despite the lack of compelling clinical data, dietary fiber is the treatment of choice for many bowel disorders.

Potential negative effects of dietary fiber. Potential negative effects of dietary fiber include reduced absorption of vitamins, minerals, proteins, and calories. It is unlikely that healthy adults who consume fiber in amounts within the recommended ranges will have problems with nutrient absorption; however, dietary fiber recommendations of 25 g/day may not be appropriate for children and the elderly since so little research has been conducted in these populations.

Generally, dietary fiber in recommended amounts is thought to normalize transit time and should help when either constipation or diarrhea is present; however, case histories have reported diarrhea when excessive amounts of dietary fiber are consumed (76), so it is difficult to individualize fiber intake based on bowel function measures. Thus, stool consistency cannot be used as a benchmark of appropriate dietary fiber intake. Intestinal obstruction caused by a cecal bezoar was reported in a seriously ill male given fiber-containing tube feedings and who was also receiving intestinal motility suppressing medications. (77). The bezoar resulted in mesenteric hemorrhage.

Fermentation of dietary fiber by anaerobic bacteria in the large intestine produces gas, including hydrogen, methane, and carbon dioxide, which may be related to complaints of distention or flatulence. When dietary fiber is increased, fluid intake should be also, and fiber should be increased gradually to allow the gastrointestinal tract time to adapt. Further, normal laxation may be achieved with smaller amounts of dietary fiber, and the smallest dose that results in normal laxation should be accepted.

Fiber-enriched enteral formulas may cause blockages in small-bore feeding tubes. This is most problematic with gums and other viscous fibers. Formulas containing fiber tend to be more expensive than standard formulas, making them a difficult choice in the absence of compelling clinical data. Few data have been published on the effectiveness of fiber-containing formulas in the long-term setting, and less expensive and more effective laxation aids are available.

Research-based recommendations about which patients are good candidates for fiber-containing enteral formulas cannot be made. Tube-fed patients with constipation or diarrhea who are known to have otherwise healthy gastrointestinal tracts should be considered candidates for fiber-containing enteral formulas. Because of the potential protective role of fiber against diverticulosis, colon cancer, diabetes, and heart disease, a fiber-enriched enteral formula may be indicated for patients in long-term enteral feeding. Fiber-containing enteral formulas may work better for certain patients, and they should be used if they produce positive results. Clinicians should be cautious in prescribing fiber-containing enteral products. Because of the wide individual variability of responses to dietary fiber and the potential problems with large doses, the smallest dose of dietary fiber that gives the desired result should always be used.

CONCLUSIONS

Chronic insufficient intake of dietary fiber represents a challenge for the dietetics professional that can be met with enthusiastic recommendations for a healthy dietary pattern.

Modest increases in intakes of fruits, vegetables, legumes, and whole- and high-fiber grain products would bring the majority of the North American adult population close to the recommended range of dietary fiber intake of 20-35 g/day. In addition, a higher fiber intake provided by foods is likely to be less calorically dense and lower in fat and added sugar. The benefits of such a varied dietary plan cannot be overemphasized. Many of the diseases of public health significance—obesity, cardiovascular disease, type 2 diabetes—as well as the less prevalent, but no less significant diseases of colonic diverticulosis and constipation, can be prevented or treated by increasing the amounts and varieties of fiber-containing foods. Promotion of such a food plan by the dietetics professional and implementation by the adult population should increase fiber intakes of children.

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