

# **Dietary Fiber**

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## **Executive Summary**

- Dietary fiber is not one substance but many. It is defined as that portion of plant foods that cannot be digested by the nonmicrobial enzymes in the human digestive tract, and it includes a variety of different chemical components.
- The best accepted beneficial effect of dietary fiber is relief of constipation. Wheat bran, in particular, has been shown to be helpful in maintaining regularity.
- Some types of fiber—including pectin, guar gum, and the fibers found in oat products, psyllium and legumes—reduce blood cholesterol levels to a small but measurable extent. These products may be of value as an adjunct to a cholesterol-lowering diet.
- As a general rule, diets with more fiber-containing foods are believed to be healthier than diets with less fiber. It is uncertain, however, whether the benefit lies in the fiber itself. High-fiber diets are usually moderate in fat and calories and high in vitamins, minerals and nonnutritive phytochemicals. Any or all of these factors may be more important than the diets' fiber content.
- The use of fiber supplements for the purpose of preventing cancer or heart disease is not recommended. Instead, experts urge people to get their fiber from a well-balanced diet that includes grains, legumes, vegetables and fruits.
- Current dietary recommendations for people with diabetes do not call for higher fiber intakes than are recommended for the general public.

- Individuals who are dieting to lose weight often find it helpful to include high-fiber foods in their diets, since these foods are usually low in calories and so help to produce a feeling of fullness. It is uncertain, however, whether fiber has any specific benefits in weight control.
- For individuals who currently consume low-fiber diets, moderate increases in the consumption of fiber-rich foods are generally safe, as long as they are accompanied by increases in fluid intake.
- Fiber-rich foods have a place in children's diets, just as they do in the diets of adults.

Excessively high intakes of high-fiber foods, however, may interfere with a child's ability to consume enough calories for normal growth. The Daily Value for fiber that is listed on food labels is too high for children; parents should not attempt to include that much fiber in their children's diets.

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## Introduction

The term “dietary fiber” is familiar to most Americans. Many people, however, do not fully understand the nature of dietary fiber and its role in a healthful diet. In this report the American Council on Science and Health reviews current scientific knowledge about the role dietary fiber plays in the prevention and treatment of human diseases and explains the potential benefits and risks of increased fiber intake.

## What Is Dietary Fiber?

Dietary fiber is that portion of plants that cannot be digested by the nonmicrobial enzymes of the human digestive tract. Fiber consists of a variety of substances, most of which are complex carbohydrates.

It is important to remember that fiber is naturally present *only* in foods derived from plants—fruits, vegetables, grains and legumes (beans). Foods of animal origin (even “stringy” meats) contain no fiber. Whole grains contain substantially more fiber than refined grains do, because the refining process removes some of the fiber from the grains. As a general rule, the fiber content of whole grains, nuts and legumes is higher than that of refined grains, fruits and vegetables other than legumes.

Scientists have found it useful to distinguish two types of dietary fiber: “soluble” and “insoluble.” This distinction is important because the two types of fiber have different effects on the human body. Most plant foods contain a mixture of both types of fiber, with insoluble fiber predominating, but the proportion of soluble and insoluble fibers in different foods varies.

Scientists are still in the process of developing accurate methods for analyzing the soluble and insoluble fiber content of foods. Published values for specific foods vary, depending on the analytical procedures used to develop them. Because techniques for measuring the soluble and insoluble fiber content of foods are still evolving, and because the experts have not yet decided which is the most appropriate method of analysis and classification, values for these types of fiber are not yet included on food labels. Only total fiber is listed at present.

The amounts of soluble and insoluble fiber that researchers at the University of Wisconsin found in a variety of foods are shown in Table 1 on page XX. Although these values were obtained with up-to-date methods,<sup>1</sup> they should be considered illustrative rather than definitive.

Soluble fibers are those that, when mixed with water, remain suspended in it, while insoluble fibers do not. It is important to point out that this definition is based on the characteristics of pure fibers as studied in the laboratory. Since the purification process can alter the structure—and thus the reactions—of the fibers, it is not clear that exactly the same characteristics would be observed in the complex mixture of fibers found in fiber-rich foods. Further, bacteria in the large intestine can break down some, but not all of, the fibers in foods, which could also change the way the fibers interact with each other and with other compounds in the intestine.

Soluble fibers include gums, mucilages, some pectins and some hemicelluloses. Foods that contain substantial proportions of soluble fiber include oats, barley, legumes and certain vegetables such as white potatoes and sweet potatoes. Most other grains, fruits and vegetables contain smaller proportions of soluble fiber. Most soluble fibers can be broken down by the enzymes produced by the bacteria in the large intestine.

Insoluble fibers include lignin, cellulose and some hemicelluloses and pectins. Foods almost always contain more insoluble fiber than soluble fiber.<sup>1</sup> Foods particularly rich in insoluble fiber include whole wheat and wheat bran. Insoluble fibers are resistant to breakdown by the bacterial enzymes of the large intestine.

### **The Growing Interest in Fiber**

A couple of generations ago, people used the terms “bulk” or “roughage” to refer to the food components now known as dietary fiber. Roughage was considered valuable in the diet primarily because it helped to prevent constipation; it was not considered necessary for any other purpose.

In the early 1970s, however, some scientists suggested that fiber might have additional health benefits. One of the leading proponents of this view was the late Dr. Denis Burkitt, a British physician who had spent many years practicing medicine and conducting medical research in Africa.<sup>2</sup> Dr. Burkitt and other physicians noticed that a number of health problems—including coronary heart disease, diabetes, gallstones, diverticular disease of the colon, appendicitis, hiatal hernia, hemorrhoids, varicose veins, chronic constipation and colon cancer—were common among the populations of technologically advanced Western countries but rare among rural Africans. Burkitt and others

proposed that the high fiber content of their African patients' traditional diets might be protecting them against these diseases and disorders.<sup>3</sup> In the view of these doctors, the low dietary fiber content of typical Western diets was likely to contribute to a wide variety of health problems.

The dietary fiber hypothesis proposed by Dr. Burkitt and his associates more than two decades ago is still of great interest to scientists today. As research on dietary fiber has progressed, however, it has become evident that the relationship between fiber and health is not as direct as Dr. Burkitt originally envisioned.

One reason why the effects of fiber are difficult to unravel is that fiber is a complex mixture of substances, not a single chemical entity. Various types of dietary fiber may have different physiological effects. Also, fiber is not consumed in isolation. Foods rich in fiber contain a wide variety of other substances, some of which may contribute to disease prevention.

Some of the health benefits associated with a high-fiber diet may come from the vitamins, minerals or nonnutritive phytochemicals present in high-fiber foods, rather than from the fiber itself. Some health effects associated with fiber might also be due to the substitution of high-fiber foods for less healthful foods (eating a bran muffin instead of a sweet roll); to the relatively low fat and calorie levels in most high-fiber diets; or to the correlation between high-fiber diets and other healthful lifestyle choices (such as regular exercise). In addition, comparisons made between population groups (such as the observations made by Dr. Burkitt) may not be directly applicable to individuals. (Just because societies that eat high-fiber diets have a low frequency of constipation, for example, it does not necessarily follow that an increase in fiber intake would relieve constipation in a specific Western individual).

### **Fiber Versus Food**

For most of the diseases and health conditions discussed in this report, the scientific evidence supporting a beneficial effect from a fiber-rich diet is far stronger and more convincing than the evidence for a specific effect of fiber itself. For this reason, experts generally advise people to increase their intake of dietary fiber by increasing their consumption of grains, legumes, vegetables and fruits rather than by taking fiber supplements.

There are some exceptions to this principle. Certain types of fiber supplements have been shown to be beneficial in the treatment of specific health problems. Physicians often recommend

fiber supplements for patients with chronic constipation, for example; and there is scientific evidence indicating that these products are, indeed, helpful in the management of this problem. In general, however, fiber supplements are not the best choice for the prevention of chronic diseases and the promotion of good health. Instead, experts advise people to eat a balanced diet that includes a variety of fiber-rich plant foods and to make that diet part of an overall healthy lifestyle—one that also emphasizes other disease-prevention strategies such as abstinence from tobacco and illegal drugs, maintenance of a healthy weight, regular physical activity and moderation in the use of alcohol (if it is used at all).

### **Grains, Fruits and Vegetables**

Most of the current scientific literature on the benefits of plant foods focuses on vegetables and fruits rather than on grain products. This does not necessarily mean that grains are not beneficial; it may simply reflect the difficulties that scientists encounter when they try to evaluate the effects of grains.

Some scientific studies seem to indicate that high intakes of grain products are associated with good health, while others suggest the opposite. One reason for this inconsistency is that in many societies, high intakes of grains are a marker for poverty, which is usually associated with poorer health. It is difficult to separate the health effects of grains *per se* from the effects of low socioeconomic status. Grains are also difficult to study because the nutrient content of whole-grain products differs substantially from that of refined-grain products.

Although scientific knowledge about the health effects of grain products is not as extensive as knowledge about the effects of fruits and vegetables, most authorities advise people to include ample amounts of grains in their daily diets. Grains are low in fat and high in nutritionally desirable complex carbohydrates. And, in addition to providing fiber, grains contribute B vitamins and minerals to the diet.

### **How Much Fiber Should People Consume?**

No specific Recommended Dietary Allowance for dietary fiber has been established in the U.S.,<sup>4</sup> and no quantitative guidelines on dietary fiber intake are included in the current Dietary Guidelines for Americans.<sup>5</sup> Some authorities have suggested, however, that a fiber intake in the

range of 20 to 35 grams per day would be beneficial for adults.<sup>6</sup> The Daily Values used in food labeling suggest a dietary fiber intake of 25 grams per day for persons consuming 2,000 calories daily and 30 grams per day for those consuming 2,500 calories. For Americans to achieve these fiber intakes, they would have to substantially change their dietary habits; typical fiber intakes of U.S. adults are currently about 13 grams per day.<sup>7</sup>

The exact amount of fiber that a person consumes may be less important, however, than the overall quality of the diet that supplies that fiber. Because many of the benefits associated with fiber-rich foods may not be attributable to fiber itself, it is more important for people to eat plenty of grains, vegetables (including legumes) and fruits than to try to reach a particular number of grams of fiber per day.

## **Dietary Fiber and Specific Health Problems**

### *Constipation*

The best accepted beneficial effect of dietary fiber is relief of constipation.<sup>1\*</sup> Physicians frequently recommend a trial of a high-fiber diet as a first step in the treatment of constipation in adults<sup>6,8</sup> and as treatment for irritable bowel syndrome (a functional gastrointestinal disorder that may involve constipation and/or diarrhea).<sup>9</sup> Dietary fiber, in conjunction with other therapies, is also used to treat chronic constipation in childhood.<sup>10,11</sup>

Although extensive clinical experience indicates that fiber is of value in the treatment of constipation, only a few controlled scientific studies of this topic have been conducted. Most indicate some benefit, at least for wheat bran.<sup>12-15</sup> Wheat bran is believed to be helpful in relieving constipation because it absorbs water to itself while traveling through the digestive tract, thus increasing the bulk of the stool.<sup>2\*\*</sup>

Purified fiber supplements such as psyllium-seed fiber, methylcellulose or polycarbophil are sometimes used in the treatment of chronic constipation. The use of these products is generally safe as long as patients increase their fluid intake. Fiber, and especially insoluble fiber, is similar to a sponge; it absorbs large quantities of water. If fluid intake is low, fiber can actually increase constipation or even cause an obstruction of the colon.<sup>8</sup> Since concentrated fiber products provide a great deal of fiber in a very dry form, people who use these products should make a special effort to drink more fluids. The American Academy of Family Physicians suggests that people who are making an



effort to increase their fiber intake should drink an additional two glasses of water daily in addition to their usual fluid intake, unless they are already drinking more than six glasses of liquid daily.<sup>17</sup>

### *Diverticulosis*

Diverticula are small, fingerlike projections or pouches in the colon wall. It has been estimated that one third of all North Americans over the age of 45 and two thirds of all persons over the age of 85 have diverticula in their colons.<sup>18</sup> In most instances, the presence of diverticula causes no symptoms; at least 75 percent and perhaps as many as 90 percent of all individuals who have diverticula are asymptomatic.<sup>18</sup> When diverticula produce minimal or no symptoms, the condition is referred to as *diverticulosis*.

Diverticulosis usually does not lead to serious problems. In some individuals, however, the diverticula become inflamed, producing a painful and serious acute condition called *diverticulitis*. Treatment of diverticulitis may require hospitalization, antibiotic therapy and/or surgery.

Many physicians recommend that people with diverticulosis increase their fiber intake, because fiber may help relieve constipation and other mild symptoms experienced by some people with diverticulosis. Fiber is not used in the treatment of diverticulitis. In the early stages of the treatment of diverticulitis, a patient may not be allowed to eat or drink at all; when that patient is allowed to resume eating, he or she may need to be placed temporarily on a liquid or low-fiber diet until the acute problem is resolved.

Some scientific evidence indicates that a high-fiber diet may help prevent the development of diverticulosis. It has been hypothesized that low-fiber diets may contribute to the causation of diverticulosis by setting up a vicious circle of hard stools, increased straining during defecation and higher pressure in the colon, leading to the formation of diverticula.<sup>9</sup> High-fiber diets might prevent this cycle from becoming established.

The results of a large study conducted in the U.S. support the idea that fiber may have a preventive effect against diverticulosis.<sup>19</sup> That study, which involved more than 40,000 middle-aged to elderly men, showed that men with higher intakes of dietary fiber had lower risks of symptomatic diverticula. Ironically, however, the effect was attributable largely to fiber from fruits and vegetables, not to fiber from grain products. But it is grain fiber that is generally recommended to patients with diverticulosis.

## *Colon Cancer*

It has long been suspected that high intakes of dietary fiber might reduce the risk of colon cancer, one of the most common types of cancer in Western populations. Several plausible mechanisms for a protective effect have been suggested.<sup>20,21</sup> Fiber may act by increasing stool bulk, thereby diluting cancer-causing substances in the feces. It may act by decreasing transit time through the digestive tract, thereby reducing the exposure of the walls of the colon to carcinogens. More complex mechanisms that involve changes in the metabolism of potentially harmful bile acids or the production of potentially protective substances from the bacterial fermentation of soluble fibers may also play a role.

Studies of dietary fiber intake and colon cancer risk in human populations have had inconsistent results that are difficult to interpret.<sup>21-23</sup> Even when epidemiological studies have shown associations between intake of some type of fiber and the risk of colon cancer, it has been unclear whether the effect was due to the fiber itself. Scientists have not ruled out the possibility that other components of the same foods might be the true protective agents. In fact, in a combined analysis of the findings from several epidemiological studies,<sup>22</sup> the effect of vegetables was stronger than that of fiber, suggesting that components of the vegetables other than the fiber probably contributed to reducing colon cancer risk.

Two trials have been conducted in which patients with a history of precancerous colon polyps were randomly assigned to either high-fiber or low-fiber diets and observed for the recurrence of polyps.<sup>24,25</sup> One study lasted for two years; the other, for four years. In both instances, the addition of fiber to the diet did not lead to a significant decrease in the number of new polyps. It remains possible, however, that consumption of high-fiber diets for longer periods of time might help prevent polyps.

In summary, although scientists have good reason to suspect that dietary fiber might influence the risk of colon cancer, evidence from studies in human populations doesn't convincingly demonstrate that such an effect actually exists. What the evidence does indicate is that diets high in vegetables and fruits—diets that are also healthful for many other reasons—may be associated with a reduced risk of colon cancer. Diets high in whole grains may also be associated with reduced risk of colon cancer.<sup>26</sup>

It is not yet clear whether the fiber in vegetables, fruits and grains is responsible for their apparent protective effects or which components or types of fiber might contribute to the protection. For this reason, the use of purified dietary fiber supplements for the purpose of trying to prevent colon cancer is not recommended. However, a healthful diet containing plentiful amounts of vegetables, fruits and grains (especially whole grains) may be helpful, especially if combined with other healthful lifestyle practices.

### *Breast Cancer*

Most of the scientific studies of dietary fiber and cancer have focused on colon cancer, but there has been some interest in the possibility that fiber intake might also influence the risk of breast cancer. It has been suggested that high intakes of fiber might reduce the risk of breast cancer by reducing levels of the female hormone estrogen,<sup>27</sup> but this is merely a hypothesis that is in the early stages of investigation.

Some studies have shown no relationship between fiber intake and breast cancer,<sup>28</sup> while others have shown similarly strong protective effects for fiber and other vegetable and fruit components, suggesting that something in these foods, but not necessarily fiber, decreases breast cancer risk.<sup>29</sup> The currently available data are insufficient to recommend a high-fiber diet as a preventive measure against breast cancer.<sup>9</sup>

Very little is known about the relationship of fiber intake to the risk of cancer at sites other than the colon and breast.

### *Blood Cholesterol Levels*

The effect of dietary fiber on blood cholesterol levels has been a source of controversy and confusion. Over the past few years public perceptions (and news reports) on this subject have swung wildly from one extreme to another. For a while, people seemed to believe that certain sources of fiber, especially oat bran, had nearly miraculous effects on blood cholesterol levels. This initial enthusiasm was followed by an equally strong sense of disappointment when scientific studies indicated that oat bran didn't live up to expectations. At that point, many people completely gave up on fiber and turned their attention to other matters. Research on fiber and cholesterol continued, however, and by the mid 1990s enough data had accumulated to allow scientists to conclude

that fiber is neither miraculous nor worthless; its true effect falls somewhere between these two extremes.

Numerous scientific studies have established that some kinds of fiber do indeed have a cholesterol-lowering effect. This effect is specific to certain foods and supplements that contain significant amounts of soluble fiber. Those foods and supplements include oat bran and oatmeal,<sup>30</sup> pectin,<sup>31</sup> guar gum, psyllium and the fibers in legumes.<sup>32</sup> Wheat bran and cellulose do not reduce cholesterol levels.

The effect of fiber on blood cholesterol is modest, and it requires relatively large doses consumed consistently on a daily basis. An occasional bowl of oatmeal won't do the trick. Regular daily consumption of substantial amounts of oat products, however—one large bowl of ready-to-eat oat bran cereal or three packets of instant oatmeal daily—typically produces a reduction in blood cholesterol levels of about 2 to 3 percent (with considerable variation among individuals).<sup>30</sup> Substantial doses of other suitable fiber sources, such as psyllium-based bulk laxatives, would produce similar reductions in blood cholesterol.

At one time it was suspected that the cholesterol-lowering effect of oat products and other soluble fiber sources was merely the result of substituting these carbohydrate-rich foods for foods high in saturated fat and cholesterol. The evidence from numerous studies indicates that this isn't the only factor, however. If substitution was the only thing that was happening, all fiber-rich foods—regardless of the type of fiber that they contained—would have similar effects on blood cholesterol. But this is not the case. Some fiber-rich foods (such as wheat bran) do not lower blood cholesterol levels.

Oat bran and other sources of fiber should not be regarded as an *alternative* to a cholesterol-lowering diet; their effect isn't strong enough to allow them to be used in this way. However, they can be a useful *adjunct* to conventional dietary treatment. Recent research indicates that increased intake of appropriate types of fiber can lead to an additional reduction in cholesterol beyond that produced by a low-fat diet,<sup>33</sup> and that the reduction in cholesterol is not a temporary phenomenon; it persists for many months in patients who continue to consume a fiber supplement.<sup>34</sup>

Patients with high blood cholesterol levels who are interested in pursuing the option of fiber supplementation would be well advised to consult with a physician before starting to take a supplement or adding a concentrated, fiber-rich food (such as oat bran) to their diets. It's important to

choose a fiber source carefully because seemingly similar products may have different effects. For example, psyllium-based bulk laxatives lower cholesterol levels, but bulk laxatives based on methylcellulose or polycarbophil probably don't.<sup>35</sup> Guar gum works, but acacia gum doesn't.<sup>36</sup> Patients should also discuss appropriate doses and precautions with their physicians before adding large amounts of fiber to their diets. It is advisable to increase fiber intake gradually to minimize gastrointestinal side effects such as flatulence and "gas" pains.<sup>8</sup>

Fiber supplements should be consumed along with sufficient fluid to prevent the development of constipation or intestinal obstruction. Also, some individuals may need to be concerned about possible side effects: A few people are severely allergic to psyllium, for example (this problem occurs most often in individuals with extensive occupational exposure to psyllium dust)<sup>37</sup>; and a few isolated cases of esophageal obstruction have been reported in individuals taking guar gum.<sup>38,39</sup>

#### *Coronary Heart Disease*

Several studies in human populations have found inverse correlations between intakes of dietary fiber from foods and risks of coronary heart disease.<sup>40-46</sup> In general, these associations are stronger than would be expected on the basis of fiber's small effect on blood cholesterol levels. Some researchers have therefore speculated that fiber might also help to prevent heart disease in other ways—perhaps by effects on obesity, blood coagulation or glucose metabolism, or by a direct effect on the development of atherosclerosis.<sup>3\*\*\*</sup>

Other scientists have cautioned, however, that fiber *per se* may not be the true protective factor. Instead, dietary fiber intake may be primarily an indicator of a healthy lifestyle.<sup>49,50</sup> People who choose to eat high-fiber diets also tend to make many other healthy lifestyle choices, and any or all of their healthy habits may contribute to lowering their coronary risk.

Because it is unclear whether the association between high fiber intake and lowered risk of heart disease is attributable to a specific effect of fiber itself, experts recommend that people should not emphasize fiber to the exclusion of other aspects of diet and lifestyle when making an effort to minimize their risk of heart disease. Although a high-fiber diet may, indeed, be valuable, it should be regarded as only one component of an overall risk-reduction strategy.

#### *Diabetes*

In the 1980s there was great enthusiasm over the prospect of using diets very high in fiber in the treatment of diabetes mellitus. At that time it was believed that control of blood glucose levels could be substantially improved by including fiber, especially soluble fiber, in the diet. During the late 1980s and early 1990s the American Diabetes Association and other authorities recommended that people with diabetes consume as much as 40 grams of dietary fiber daily—a substantially higher amount than that recommended for the general population.<sup>51,52</sup>

More recently, however, it has become evident that the amount of fiber needed to cause a substantial improvement in blood glucose control is very large<sup>53</sup>—about triple the amount of fiber usually consumed in the U.S.<sup>54</sup> Moreover, only a few types of very viscous soluble fiber (such as guar gum) are effective; and they need to be consumed with food—perhaps even physically mixed with the food—in order to exert their effect.<sup>53</sup> Evidently, these viscous fibers influence blood glucose levels by delaying the process through which glucose or food travels through the digestive tract and is absorbed into the bloodstream.<sup>55</sup>

Experts now believe that a meaningful improvement in control of blood glucose levels can be achieved only through carefully timed, high-dose supplementation with specific types of concentrated fiber sources; it cannot be achieved through a realistic high-fiber diet composed of ordinary foods.<sup>54</sup>

In response to these newer findings, the American Diabetes Association has revised its advice on dietary fiber intake for people with diabetes. Its current nutrition recommendations, issued in 1994, no longer call for an unusually high fiber intake. Instead, the new recommended level of fiber intake for people with diabetes is the same as that for people who do not have diabetes—20 to 35 grams per day from a wide variety of food sources.<sup>56</sup> This recommendation is based on the premise that individuals with diabetes are neither more nor less likely than other members of the population to benefit from high-fiber diets.

People with diabetes who plan to increase their intake of dietary fiber should discuss their plans with their physicians or other members of their health-care teams, as changes in dietary fiber intake may lead to changes in the need for insulin or other medications.

### *Weight Control*

Foods high in fiber are usually low in calories and fat, and they tend to produce a feeling of

fullness in the stomach, at least temporarily.<sup>8</sup> For these reasons, people who are dieting to lose weight are usually encouraged to include fiber-rich foods in their diets. It is uncertain, however, whether fiber itself has any special value as a weight-loss aid.

More than 20 scientific studies have evaluated the effect of dietary fiber on caloric intake and body weight in human volunteers. According to a recent review of these studies, enough research has been conducted with wheat bran to make it clear that this source of fiber does not reduce food intake or body weight.<sup>57</sup> Other types of fiber have not been studied as extensively, however, and the possibility that they might be helpful in promoting weight loss has not been ruled out. A few studies have shown potentially promising results for various fiber sources, but none of these findings has yet been confirmed.

All of the studies conducted to date on dietary fiber and weight loss have been short-term studies lasting no longer than three months.<sup>57</sup> Weight control, however, is a lifelong concern. People can lose weight on practically any type of properly designed, short-term diet; the real challenge is keeping the weight off for a long period of time. Unfortunately, no studies have established whether dietary fiber is of benefit in the long-term maintenance of weight loss.

### **Potential Hazards of Dietary Fiber**

The consumption of moderate quantities of dietary fiber from foods is generally believed to be safe. Concerns have been raised, however, about the possibility that adverse effects might result from the use of fiber supplements or from diets extremely high in fiber.

Many people notice gastrointestinal disturbances—such as gas pains, flatulence or diarrhea—when they increase their intake of dietary fiber. It is often stated that these symptoms decrease over time as the body adjusts to a higher fiber intake, but there is actually little evidence that this is true.<sup>8</sup> It is often recommended that people increase their fiber intake gradually to minimize gastrointestinal problems, but this suggestion comes from clinical experience rather than from controlled scientific studies.

As mentioned earlier in this report (see page XX), people who increase their intake of fiber, especially from supplements, should also increase their intake of fluids in order to avoid constipation and the risk of intestinal obstruction. Also, again as mentioned earlier (see page XX), unusual side effects such as allergic reactions and esophageal obstruction have occurred in a few individuals

taking concentrated fiber supplements. People who are considering the use of such products should discuss possible side effects with their physicians and read product labels carefully.

Substances found in fiber or associated with fiber may bind to nutritionally important minerals, thus decreasing their availability. This phenomenon is not well understood, and further research is needed. On the basis of the information currently available, however, it appears that interference with mineral nutrition is unlikely to be a problem for people consuming high-fiber, Western-style diets, because the mineral content of these types of diets is relatively high.<sup>58</sup> The mineral content of high-fiber diets is likely to be higher than that of low-fiber diets because fiber and minerals are found together in many foods.

The effects of fiber on mineral nutrition may, however, be a significant problem in some developing countries, where mineral nutrition may already be marginal.<sup>59</sup> It is believed, for example, that the problem of zinc deficiency in the Middle East is exacerbated by high dietary intakes of phytate, a component found along with fiber in some plant foods.<sup>4</sup> It is also possible that concentrated fiber supplements might have a significant effect on mineral availability, since the supplements, unlike fiber-rich foods, do not provide minerals. This is one of several reasons why most authorities consider foods to be more desirable than supplements as sources of dietary fiber.<sup>58</sup>

### **Fiber in the Diets of Children**

Several recent reports in scientific journals have urged that the diets of American children be modified to include larger amounts of dietary fiber.<sup>60-62</sup> Fiber is valuable in children's diets because it helps prevent constipation, a common childhood problem.<sup>61</sup> Inclusion of fiber-rich foods in the diet may also accustom children to eating habits that may reduce their risk of chronic diseases in adulthood.

It is important, however, to be cautious about imposing any dietary modifications or restrictions on children. Overenthusiastic efforts to bring children's diets into compliance with guidelines designed for adults may do more harm than good. Unlike adults, children need to grow and develop. Their immediate need for enough calories and nutrients to support normal growth must take precedence over the hope of preventing chronic diseases many decades later.

High intakes of dietary fiber could interfere with good nutrition and normal growth in childhood, especially for small children. Many high-fiber foods are bulky and low in calories; small chil-



dren who eat large amounts of these foods may have difficulty getting enough calories to meet their needs.<sup>59,60</sup> Excessive consumption of high-fiber foods may also affect mineral nutrition, especially in children whose mineral intake is marginal to begin with.<sup>59</sup>

These concerns apply primarily to diets extremely high in fiber and to the use of concentrated fiber supplements. Moderate increases in the consumption of fiber-rich foods are believed to be safe for children, as long as the child's total diet includes foods from all of the major food groups. Diets that emphasize high-fiber, low-calorie foods to the exclusion of other food groups are not appropriate for children.<sup>61,63</sup>

Most experts recommend that dietary fiber supplements not be given to children except for a specific medical purpose.<sup>61,64</sup> Some experts have also urged caution about the frequent inclusion of fiber-supplemented foods (such as bran cereals) in children's diets, because overuse of these products could lead to appetite suppression.<sup>64</sup>

Two expert groups have issued quantitative recommendations for dietary fiber intake for children. The American Academy of Pediatrics recommends 0.5 grams of dietary fiber per kilogram of body weight.<sup>65</sup> The American Health Foundation recommends that dietary fiber intake for children 3 years of age and older should be equivalent to at least age plus 5 grams per day.<sup>62</sup> Both of these recommendations are higher than the typical current dietary fiber intake of most age groups of U.S. children. For preadolescents, however, both recommendations are *lower* than the Daily Value for dietary fiber that is listed on food labels. (The Daily Value is based on total calorie intake; it calls for 12 grams of fiber per 1,000 calories.) Parents should not use the Daily Value for dietary fiber as a guide to planning their children's diets.

### **How to Increase Your Fiber Intake**

For those who would like to increase their intake of fiber-rich foods, here are some practical suggestions (for more detailed information on planning a high-fiber diet, see the appendix on page XX):

- Make an effort to follow the serving recommendations in the Food Guide Pyramid. That means eating at least six servings of grain products, at least three servings of vegetables and at least two

servings of fruits daily. Most Americans eat fewer than the recommended number of servings of these foods,<sup>5</sup> so there is plenty of room for improvement. The box “Fiber and the Food Guide Pyramid” (see page XX) gives more specific information on serving sizes and fiber-rich food choices.

- Choose whole-grain foods more often and refined-grain foods less often. Examples of whole grain foods include 100-percent whole-wheat bread, brown rice, oatmeal, popcorn and whole-grain ready-to-eat cereals. The average American eats a whole-grain food only once every two days,<sup>66</sup> so there’s plenty of room for improvement here, too.
- Choose fruits more often and fruit juices less often.
- Eat legumes (such as kidney beans, lima beans or lentils) a few times a week.
- Make sure to increase your fluid intake if you increase your intake of dietary fiber.

<sup>1\*</sup>Individuals with constipation should consult with a physician before adding fiber to their diets. Although fiber is helpful in many instances, it can actually be harmful in some patients. Also, some cases of constipation are due to structural or metabolic problems (e.g., medication toxicity) that can be corrected. The physician should evaluate the patient for such conditions before starting treatment.

<sup>2\*\*</sup>The results of a new study indicate that oat bran increases stool weight to the same extent that wheat bran does,<sup>16</sup> despite the distinctly different nature of its fiber content. Therefore, oat bran may be helpful in the treatment of constipation. No direct comparisons of the effects of oat bran and wheat bran in constipated patients have yet been reported, however.

<sup>3\*\*\*</sup>Studies in experimental animals have suggested that certain types of fiber, such as grapefruit pectin, may inhibit the development of atherosclerosis even if they do not reduce the animals’ cholesterol levels.<sup>47,48</sup> Further research is needed to determine whether similar effects occur in humans.

## **Fiber and the Food Guide Pyramid**

If you’re trying to plan a healthful diet that includes appropriate amounts of fiber, the Food Guide Pyramid is a good starting point. To begin with, you should make sure that you’re getting at least the recommended number of daily servings of each of the three food groups at the bottom of the pyramid—grains, fruits and vegetables. Then look at your choices within each of these groups, and make sure that at least some of them are rich in fiber.

You should eat at least six servings of grain products daily. You can count any of the following as one serving:

- 1 slice of bread;
- 1 ounce of ready-to-eat cereal;

- 1/2 cup of cooked cereal, rice or pasta.

The best sources of fiber in the grain group are products that contain bran (wheat-bran or oat-bran cereals, bran muffins) and whole-grain products (whole-wheat bread, oatmeal, whole-wheat pastas, brown rice). Products made from refined grains (white bread, white rice, most pastas) also contribute some fiber to the diet, but they contain less fiber than their whole-grain equivalents.

You should eat at least two servings of fruit daily. You can count any of the following as one serving:

- 1 medium apple, banana, orange or other piece of whole fruit;
- 1/2 cup of chopped, cooked, frozen or canned fruit;
- 3/4 cup of fruit juice.

Some of the fiber in fruits is in or just under the skin. Therefore, the fiber content of a fruit eaten with the skin (such as an unpeeled apple) is higher than that of a fruit eaten without the skin (such as a peeled apple). Fruit juices contain very little fiber.

You should eat at least three servings of vegetables daily. You can count any of the following as one serving:

- 1 cup of raw leafy vegetables;
- 1/2 cup of other vegetables, either cooked or chopped raw;
- 3/4 cup of vegetable juice.

Vegetables eaten with the skin (such as a baked potato with skin) contain more fiber than those eaten without the skin (such as mashed potatoes or French fries). Vegetable juices contain very little fiber.

Legumes (kidney beans, chickpeas, lentils) are an excellent source of fiber. Legumes fit into the Food Guide Pyramid in two different places: You can count 1/2 cup of cooked legumes as one serving of vegetables; or, if you prefer, you can substitute 1/2 cup of cooked legumes for one ounce of meat. Since a standard serving of meat is 2 to 3 ounces, 1/2 cup of cooked legumes counts as one third to one half of a meat-group serving.

**Table 1.****Dietary Fiber Content of Some Common Foods.**

<b>Food</b>	<b>Portion Size</b>	<b>Dietary Fiber (grams)</b>		
		<b>Total</b>	<b>Soluble</b>	<b>Insoluble</b>
<i>Fruits</i>				
apple, unpeeled, large	1	3.6	0.3	3.3
apple, peeled, large	1	2.6	0.3	2.3
grapefruit, with membrane	1/2	2.5	0.5	2.0
grapefruit sections	1/2 cup	0.5	0.1	0.4
banana	1	2.9	0.8	2.1
<i>Vegetables</i>				
broccoli	1/2 cup, cooked	2.7	0.3	2.4
carrot	1 raw	2.1	0.2	1.9
tomatoes, canned	1/2 cup	0.9	0.2	0.7
potato, baked, with skin	1	4.9	3.7	1.2
corn, whole kernel	1/2 cup, cooked	1.7	0.1	1.6
<i>Grain products</i>				
cereal, 40% bran flakes	1 cup	7.6	0.8	6.8
cereal, corn flakes	1 cup	1.1	0.1	1.0
cereal, oat bran, uncooked	1/3 cup	4.8	1.8	3.0
cereal, oatmeal, cooked	1 cup	4.4	1.7	2.7
bread, white	1 slice	0.7	0.2	0.5
macaroni, cooked	1 cup	2.5	0.3	2.2
<i>Legumes and nuts</i>				
kidney beans, canned	1/2 cup	6.6	1.5	5.1
lima beans, canned	1/2 cup	3.6	0.4	3.2

green peas, canned	1/2 cup	2.8	0.3	2.5
almonds, with skin	15 nuts	5.6	0.6	5.0
peanuts, roasted in shell	10 nuts	1.9	0.1	1.8
peanut butter	1 tbsp	1.1	0.1	1.0

Adapted from: Albertson AM, Tobelmann RC. Consumption of grain and whole-grain foods by an American population during the years 1990 to 1992. *J Am Diet Assoc* 1995;95:703–704.

## References

- 1 Marlett JA. Content and composition of dietary fiber in 117 frequently consumed foods. *J Am Diet Assoc* 1992;92:175–186.
- 2 For an interesting overview of Dr. Burkitt's life and career, readers may wish to consult the articles by Ethel R. Nelson and Cory SerVaas in the March–April 1995 issue of the *Saturday Evening Post*.
- 3 Burkitt DP, Trowell HC. *Refined Carbohydrate Foods and Disease: Implications of Dietary Fiber*. London: Academic Press; 1975.
- 4 Subcommittee on the Tenth Edition of the RDAs, Food and Nutrition Board, Commission on Life Sciences, National Research Council. *Recommended Dietary Allowances*. 10th ed. Washington, DC: National Academy Press; 1989.
- 5 *Nutrition and your Health: Dietary Guidelines for Americans*. 4th ed. Home and Garden Bulletin No. 232. Washington, DC: U.S. Departments of Agriculture and Health and Human Services; 1995.
- 6 Position of the American Dietetic Association: Health implications of dietary fiber. *J Am Diet Assoc* 1993;93:1446–1447.
- 7 Lanza E, Jones DY, Block G, Kessler L. Dietary fiber intake in the U.S. population. *Am J Clin Nutr* 1987;46:790–797.
- 8 Gray DS. The clinical uses of dietary fiber. *Am Fam Phys* 1995;51:419–425.
- 9 Bennett WG, Cerda JJ. Dietary fiber: fact and fiction. *Dig Dis* 1996;14:43–58.
- 10 McClung HJ, Boyne L, Heitlinger L. Constipation and dietary fiber intake in children. *Pediatrics* 1995;96:999–1001.
- 11 Hillemeier C. An overview of the effects of dietary fiber on gastrointestinal transit. *Pediatrics* 1995;96:997–999.
- 12 Badiali D, Corazziari E, Habib FI et al. Effect of wheat bran in treatment of chronic nonorganic constipation. A double-blind controlled trial. *Dig Dis Sci* 1995;40:349–356.

- 13 Graham DY, Moser SE, Estes MK. The effect of bran on bowel function in constipation. *Am J Gastroenterol* 1982;77:599–603.
- 14 Marcus SN, Heaton KW. Effects of a new, concentrated wheat fibre preparation on intestinal transit, deoxycholic acid metabolism and the composition of the bile. *Gut* 1986;27:893–900.
- 15 Muller-Lissner SA. Effect of wheat bran on weight of stool and gastrointestinal transit time: a meta analysis. *Br Med J* 1988;296:615–617.
- 16 Hosig KB, Shinnick FL, Johnson MD, Story JA, Marlett JA. Comparison of large bowel function and calcium balance during soft wheat bran and oat bran consumption. *Cereal Chem* 1996;73:392–398.
- 17 American Academy of Family Physicians. How to increase the amount of fiber in your diet [patient information handout]. *Am Fam Phys* 1995 (Feb 1);51(2) [no page number].
- 18 Roberts PL, Veidenheimer MC. Diverticular disease of the colon. In: Bayless TM, ed. *Current Therapy in Gastroenterology and Liver Diseases*. Philadelphia: BC Decker Inc. 1990;416–419.
- 19 Aldoori WH, Giovannucci EL, Rimm EB et al, A prospective study of diet and the risk of symptomatic diverticular disease in men. *Am J Clin Nutr* 1994;60:757–764.
- 20 Kaaks R, Riboli E. Colorectal cancer and intake of dietary fibre. A summary of the epidemiological evidence. *Eur J Clin Nutr* 1995;49 (Suppl 3):S10–S17.
- 21 Giovannucci E, Willett WC. Dietary factors and risk of colon cancer. *Ann Med* 1994;26:443–452.
- 22 Trock B, Lanza E, Greenwald P. Dietary fiber, vegetables, and colon cancer: critical review and meta-analyses of the epidemiologic evidence. *J Natl Cancer Inst* 1990;82:650–661.
- 23 Howe GR, Benito E, Castelletto R et al. Dietary intake of fiber and decreased risk of cancers of the colon and rectum: evidence from the combined analysis of 13 case-control studies. *J Natl Cancer Inst* 1992;84:1887–1896.
- 24 McKeown-Eyssen GE, Bright-See E, Bruce WR, Jazmaji V. A randomized trial of a low fat high fibre diet in the recurrence of colorectal polyps. Toronto Polyp Prevention Group. *J Clin Epidemiol* 1994;47:525–536.
- 25 MacLennan R, Macrae F, Bain C et al, Randomized trial of intake of fat, fiber, and beta carotene to prevent colorectal adenomas. The Australian Polyp Prevention Project. *J Natl Cancer Inst* 1995;87:1760–1766.
- 26 Jacobs DR Jr, Slavin J, Marquart L. Whole grain intake and cancer: a review of the literature. *Nutr Cancer* 1995;24:221–229.
- 27 Rose DP. Dietary factors, hormones, and breast cancer risk. *Proc Annu Meet Am Assoc Cancer Res* 1995;36:685–686.
- 28 Willett WC, Hunter DJ, Stampfer MJ et al. Dietary fat and fiber in relation to risk of breast cancer. An 8-year follow-up. *JAMA* 1992;268:2037–2044.

- 29 Howe GR, Hirohata T, Hislop TG et al. Dietary factors and risk of breast cancer: combined analysis of 12 case-control studies. *J Natl Cancer Inst* 1990;82:561-569.
- 30 Ripsin CM, Keenan JM, Jacobs DR Jr et al. Oat products and lipid lowering. A meta-analysis. *JAMA* 1992;267:3317-3325.
- 31 Cerda JJ, Robbins FL, Burgin CW, Baumgartner TG, Rice RW. The effects of grapefruit pectin on patients at risk for coronary heart disease without altering diet or lifestyle. *Clin Cardiol* 1988;11:589-594.
- 32 Glore SR, Van Treeck D, Knehans AW, Guild M. Soluble fiber and serum lipids: a literature review. *J Am Diet Assoc* 1994;94:425-436.
- 33 Jenkins DJA, Wolever TMS, Rao AV et al. Effect on blood lipids of very high intakes of fiber in diets low in saturated fat and cholesterol. *N Engl J Med* 1993;329:21-26.
- 34 Hunninghake DB, Miller VT, LaRosa JC et al. Long-term treatment of hypercholesterolemia with dietary fiber. *Am J Med* 1994;97:504-508.
- 35 Anderson JW, Floore TL, Geil PB, O'Neal DS, Balm TK. Hypocholesterolemic effects of different bulk-forming hydrophilic fibers as adjuncts to dietary therapy in mild to moderate hypercholesterolemia. *Arch Intern Med* 1991;151:1597-1602.
- 36 Haskell WL, Spiller GA, Jensen CD, Ellis BK, Gates JE. Role of water-soluble dietary fiber in the management of elevated plasma cholesterol in healthy subjects. *Am J Cardiol* 1992;69:433-439.
- 37 Lantner RR, Espiritu BR, Zumerchik P, Tobin MC. Anaphylaxis following ingestion of a psyllium-containing cereal. *JAMA* 1990;264:2534-2536.
- 38 Opper FH, Isaacs KL, Warshauer DM. Esophageal obstruction with a dietary fiber product designed for weight reduction. *J Clin Gastroenterol* 1990;12:667-669.
- 39 Seidner DL, Roberts IM, Smith MS. Esophageal obstruction after ingestion of a fiber-containing diet pill. *Gastroenterology* 1990;99:1820-1822.
- 40 Rimm EB, Ascherio A, Giovannucci E, Spiegelman D, Stampfer MJ, Willett WC. Vegetable, fruit, and cereal fiber intake and risk of coronary heart disease among men. *JAMA* 1996;275:447-451.
- 41 Humble CG, Malarcher AM, Tyroler HA. Dietary fiber and coronary heart disease in middle-aged hypercholesterolemic men. *Am J Prev Med* 1993;9:197-202.
- 42 Fehily AM, Yarnell JW, Sweetnam PM, Elwood PC. Diet and incident ischaemic heart disease: the Caerphilly Study. *Br J Nutr* 1993;69:303-314.
- 43 Morris JN, Marr JW, Clayton DG. Diet and heart: a postscript. *Br Med J* 1977;ii:1307-1314.
- 44 Kromhout D, Bosschieter EB, de Lezenne Coulander C. Dietary fibre and 10-year mortality from coronary heart disease, cancer, and all causes. The Zutphen study. *Lancet* 1982;ii:518-522.
- 45 Kushi LH, Lew RA, Stare FJ et al. Diet and 20-year mortality from coronary heart disease. The Ireland-Boston diet-heart study. *N Engl J Med* 1985;312:811-818.

- 46 Khaw KT, Barrett-Connor E. Dietary fiber and reduced ischemic heart disease mortality rates in men and women: a 12-year prospective study. *Am J Epidemiol* 1987;126:1093–1102.
- 47 Cerda JJ, Normann SJ, Sullivan MP et al. Inhibition of atherosclerosis by dietary pectin in microswine with sustained hypercholesterolemia. *Circulation* 1994;89:1247–1253.
- 48 Cerda JJ. The pectin-cholesterol connection—a review. *Technol J Franklin Inst* 1994;331A:199–202.
- 49 Sacks FM. Editorial: Dietary fiber and cardiovascular disease—direct protection or indicator of a healthy lifestyle? *Am J Prev Med* 1993;9:259–260.
- 50 Wynder EL, Stellman SD, Zang EA. High fiber intake. Indicator of a healthy lifestyle. *J Am Med Assoc* 1996;275:486–487.
- 51 American Diabetes Association. Nutritional recommendations and principles for individuals with diabetes mellitus: 1986. ADA position statement. *Diabetes Care* 1987;10:126–132.
- 52 Anderson JW, Geil PB. New perspectives in nutrition management of diabetes mellitus. *Am J Med* 1988;85:159–165.
- 53 Nuttall FQ. Dietary fiber in the management of diabetes. *Diabetes* 1993;42:503–508.
- 54 Diabetes Care and Education, a Practice Group of the American Dietetic Association; Tinker LF, Heins JM, Holler HJ. Commentary and translation: 1994 nutrition recommendations for diabetes. *J Am Diet Assoc* 1994;94:507–511.
- 55 Gallaher DD, Schneeman BO. Dietary fiber. In: Ziegler EE, Filer LJ Jr, eds, *Present Knowledge in Nutrition*. 7th ed. Washington, DC: ILSI Press, 1996;87–97.
- 56 Nutrition recommendations and principles for people with diabetes mellitus. *J Am Diet Assoc* 1994;94:504–506.
- 57 Stevens J. Does dietary fiber affect food intake and body weight? *J Am Diet Assoc* 1988;88:939–942, 945.
- 58 Frølich W. Bioavailability of micronutrients in a fibre-rich diet, especially related to minerals. *Eur J Clin Nutr* 1995;49:S116–S122.
- 59 Williams CL, Bollella M. Is a high-fiber diet safe for children? *Pediatrics* 1995;96:1014–1019.
- 60 Williams CL. Importance of dietary fiber in childhood. *J Am Diet Assoc* 1995;95:1140–1146, 1149.
- 61 Dwyer JT. Dietary fiber for children: how much? *Pediatrics* 1995;96:1019–1022.
- 62 A summary of conference recommendations on dietary fiber in childhood (Conference on Dietary Fiber in Childhood, New York, May 24, 1994). *Pediatrics* 1995;96:1023–1028.
- 63 Committee on Nutrition, American Academy of Pediatrics. Plant fiber intake in the pediatric



diet. *Pediatrics* 1981;67:572–575.

64 Schneeman BO, Tinker LF. Dietary fiber. *Pediatr Clin North Am* 1995;42:825–838.

65 American Academy of Pediatrics, Committee on Nutrition. Carbohydrate and dietary fiber. In Barness L, ed. *Pediatric Nutrition Handbook*. 3rd ed. Elk Grove Village, IL: American Academy of Pediatrics, 1993;100–106.

66 Albertson AM, Tobelmann RC. Consumption of grain and whole-grain foods by an American population during the years 1990 to 1992. *J Am Diet Assoc* 1995;95:703–704.