

The Science Behind Advice to Eat More Whole Grains

Whole grains, such as whole wheat, bulgur, oatmeal, whole cornmeal, brown rice, buckwheat, wild rice, whole rye, whole-grain barley and quinoa, have long been recognized as both healthful and important to a balanced eating plan, but were often considered so “ho-hum” that most people made no real effort to eat them on a regular basis. Further, many health professionals recommended whole grains simply for their dietary fiber content. Recent research documents benefits of eating the recommended amount of whole grains and shows that fiber is just one of many beneficial whole-grain components. Current dietary recommendations including *Dietary Guidelines for Americans* 2005 and MyPyramid.gov emphasize whole grains, recommending at least three one-ounce equivalents of whole grain foods daily for adults. (A one-ounce equivalent of a whole grain food is expected to provide at least 16 grams of whole grain per serving.) This update reviews the benefits of including whole grains in the diet and explores possible mechanisms of action.

Whole Grains and All-Cause Mortality

Reduced All-Cause Mortality in Epidemiological Studies

In the Health Professionals' Study (N~36,000), all age cohorts, there was a 20% decrease in overall mortality for men who ate one or more servings per day (sv/d) of whole-grain breakfast cereal versus those who ate it not at all or very infrequently (1). Similarly, in a cohort (N=15,792) with significant numbers of minorities, the Atherosclerosis Risk in Communities (ARIC) Study, whole grain intake was inversely associated with total mortality (2).

In the 35,000 postmenopausal women in the Iowa Women's Health Study (IWHS), inclusion of approximately three servings of whole grains per day was associated with reduced all-cause mortality for specific age categories (3). Fiber from whole grains, not total fiber *per se*, in the IWHS was related to reduced mortality for age. Among women whose total fiber intake was the same but the sources of the fiber were different, those who ate the most fiber from whole grains had a 17% lower mortality rate at any age than those who consumed predominantly fiber from refined grains.

Whole Grains and Obesity

In examining the obesity issue, numerous dietary constituents have been named as either part of the problem or part of the solution. Whole grains are no exception. Whole-grain intake has

been shown to be inversely related to body mass index (BMI) and waist-to-hip ratio or waist circumference in a variety of populations, including adolescents and older adults (4-6).

Data from the Nurses' Health Study show that those who regularly ate whole grains were 49% less likely to gain weight over the 12 years of follow-up than were those who ate refined grains (7). However, one study showed that the inclusion of whole-oat cereal for a very short time (6 weeks) had no measurable effect on weight. This same study did indicate that whole-grain foods might have curbed hunger, which might affect longer-term studies (8). Furthermore, this study added to a growing number of studies which show that intake of whole-grain foods is inversely associated with plasma biomarkers of obesity, including insulin, C-peptide and leptin concentrations.

Constituents of whole grains such as fiber, resistant starch, magnesium and phytochemicals may affect hormones that slow gastric emptying, blunt the glycemic and insulin responses and alter satiety (9-10). All these factors are related to weight loss in some studies.

Whole Grains and Type 2 Diabetes

Intake of whole grains also appears to be associated with reduced risk of type 2 diabetes. Data from both the IWHS and the Nurses' Health Study show that those eating the most whole grains (~2.7 sv/d) had a 21% to 27% reduced risk of type 2 diabetes compared to those who ate few or no whole grains (11-12). Type 2 diabetes risk in the Health Professionals' Study (13) and in a Finnish cohort (14) was 35% to 40% lower for those with the highest intake of whole grains.

In the Insulin Resistance Atherosclerosis Study (IRAS), insulin sensitivity was directly related to whole grain intake (15). Addition of 6 to 10 sv/d of whole-grain foods or whole-grain rye improved insulin sensitivity and lowered fasting insulin by 10% (16-17).

Improvements in blood glucose and insulin sensitivity and reduced risk of diabetes can be related to whole grain intake through a variety of mechanisms. First, the starch in whole grains is slowly released, causing a slow steady infusion of glucose into the bloodstream. Second, some of the starch is not digested (i.e., it is resistant starch). Third, fiber, especially the viscous fiber in whole grains such as oats and barley, modulates blood glucose and blunts the glycemic response. Improved insulin sensitivity may also be mediated by magnesium and other whole grain constituents including antioxidants.

Whole Grains and Coronary Heart Disease

The viscous fibers in oats and oatmeal have long been associated with reduced blood cholesterol and coronary heart disease (CHD). As part of a low-fat diet, oat foods with sufficient beta-glucan lower cholesterol by 3% to 8%. This has been calculated as a reduction of CHD risk of 6% to 16% (18-22).

Ingestion of whole grains shows an even greater impact on CHD risk reduction than would be predicted from fiber's effect on blood cholesterol alone (23-26). For example, prospective cohort studies show that those who ate ~3 sv/d of whole-grain foods had a 30% to 36% lower risk of ischemic heart disease compared to those who ate little or no whole-grain foods daily (1, 25, 24).

Since risk reductions with whole grains are greater than predicted by fiber's effect on cholesterol alone, other whole-grain components appear to be exerting positive impact on cardiovascular risk factors. These could include folate, vitamins B-6 and E, magnesium and many of the phytochemicals. For example, antioxidants may protect LDL cholesterol from oxidation, affect LDL size, change vascular reactivity, minimize coagulation, alter fibrinolysis, reduce inflammation and improve insulin sensitivity. One study showed that there was a tendency towards less vessel narrowing in women with higher intake of cereal fiber or whole-grain foods. No such relationship was seen with total, fruit or vegetable fiber (27).

Whole grains have also been studied in relation to other cardiovascular disorders such as stroke and hypertension. For instance, in the Nurses' Health Study, whole grain intake was associated with a 36% decrease in ischemic stroke (28). However, no decrease in stroke was seen in the ARIC study (2). One study showed that whole grain intake was associated with lower blood pressure; another showed that whole grain intake could reduce the amount of blood pressure medicine required by individuals with mild hypertension (29-30).

Whole Grains and Cancer

Whole grain intake is associated in epidemiological studies with reduction in cancer risk from 10% to nearly 50%, depending on the type of cancer studied. For instance, postmenopausal women in the tertile eating the most whole grains had a relative risk for gastrointestinal cancers of 0.53 (31). A case-control study of cancers of the pharynx, esophagus and larynx showed that those who ate the most refined grains had an odds ratio = 5.7, whereas those who ate the most whole grains had an odds ratio = 0.5 (32). In a cohort of 35,000 Italian women, those ingesting fiber from the highest tertile of refined grains had nearly a 6-fold elevated risk

of upper GI cancers, while those ingesting fiber from the highest tertile of whole grains had a reduced odds ratio = 0.5 (33).

Intake of whole grains and dietary fiber as a potential way to reduce the risk of colorectal cancer has been inconclusive, since some studies have failed to show reduced risk (34-36). It may be that the intake of fiber even in the cohort eating the highest amount of fiber was too low to reduce cancer risk, the interventions were too short or the methods were inadequate to show positive results. More recently in the Prostate, Lung, Colorectal and Ovarian Cancer Screening Trial (N=33,971), those ingesting the highest quintile of dietary fiber had a 27% lower risk of adenomas than those in the lowest quintile (37). In the European Prospective Investigation into Cancer and Nutrition (EPIC) (N~520,000), the quintile ingesting the most dietary fiber had a 25% reduced risk of large bowel cancer (38). For 61,433 women in the Swedish Cancer Registry, high intake of whole grains (4.5 or more sv/d) was associated with a 33% lower risk of colon cancer (39).

Whole grains may act to help reduce the risk of gastrointestinal cancers in a number of ways. Inulin, resistant starch and other fermentable fibers found in whole grains encourage butyrate production in the colon. Butyrate and other short chain fatty acids lower colonic pH, feed healthy colonic cells, encourage beneficial bacterial species and impair production of potentially destructive secondary bile acids. Bran and other fibrous components facilitate faster transit time and dilution of fecal material so carcinogens in the colon have reduced chance to interact with surrounding tissue. Additionally, whole grain antioxidants and phytochemicals may act to prevent destructive oxidation (31, 33).

Whole grains may help reduce the risk of sex hormone-related cancers. Postulated mechanisms include lowering of sex hormone production via phytoestrogens, such as those in rye (40-41).

Summary

Whole grains and their individual components interact to offer possible health benefits. The popularity of whole grains is rising. Recent data show that fiber intake from whole-grain foods has increased since the release of the *Dietary Guidelines for Americans* 2005 (42). Because many people in the US fall short of the recommended intake, strategies to increase both the variety and number of whole-grain foods are important to help individuals obtain essential nutrients, different types of fiber and important phytochemicals. The introduction of new products formulated with whole grains can help Americans meet current dietary

advice to increase consumption of whole grains. A scan of the marketplace shows a variety of new products made with whole grains from which consumers can choose.

Numerous epidemiological studies link whole grains with disease risk reduction. However, because whole grain eaters often have other healthful habits such as eating less fat and more fruits and vegetables and regularly engaging in physical activity, a precise

causal relationship between whole grain intake itself and disease risk reduction has not been established. As a result, some suggest that high intake of whole grains is merely a marker of good health habits. What is known is that eating more whole grains will increase both dietary fiber and phytochemical intake. As such, some suggest that whole grains are an integral part of a diet that may prevent chronic disease (43).

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