

Health Benefits and Recommendations for Daily Whole Grain Intake

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ABSTRACT

Cereals are staple foods in the diet of many populations, and they are essential sources of carbohydrate energy, protein, dietary fiber, and numerous phytochemicals and micronutrients. Retaining all of these components in the form of whole grains and whole grain foods improves the quality of the diet, and there is strong evidence, especially from observational studies, that consumption of whole grains results in health benefits. Increasing whole grain consumption is, therefore, a target for health organizations, with recommendations for intake proposed in many countries. However, intake remains universally low, except in some Northern European countries, and so new strategies and partnerships between industry and health agencies are needed to promote whole grain consumption. Consolidating definitions for whole grain and whole grain foods is an important initial step to better inform consumers and encourage the development of new whole grain foods by industry.

Whole grains, and foods made from them, are recommended for consumption as replacements for foods made from refined grains, because they provide greater carbohydrate quality. In particular, whole grains have a higher fiber content compared with refined grains, as well as delivering a multitude of micronutrients and phytochemicals associated with the bran and germ into the diet. There is considerable evidence showing that people who consume more whole grains have a lower risk of some chronic diseases, and they are less likely to be overweight than people who consume the least amount of whole grains. Some, but not all, health agencies encourage whole grain consumption; the benefits of whole grains should be broadcast more widely to encourage their consumption and improve diet quality and health.

The invention of the roller mill during the industrial revolution contributed to many advances in food manufacturing processes. Roller milling was cheaper and faster than stone grinding of cereals, and the market for white (refined) flours rapidly outgrew that of wholemeal flours. White flour was thought to be purer and was more popular with consumers than wholemeal flour. White flour also had a longer shelf life because of its lower oil content and was easier to use in large-scale bakeries. The result was a complete transformation in the food supply chain, where refined white flours became the dominant staple cereal product at the expense of wholemeal flours. The nutritional consequences of using refined rather than wholemeal flours were not immediately obvious, and it took some time be-

fore fortification of white flour was mandated in some countries to replace some of the minerals and vitamins lost during the refining process. In general, wholemeal flours are richer in dietary fiber, protein, micro- and macronutrients, and phytochemicals but are lower in total carbohydrate. The debate continues today, with international panels debating the merits of folate and vitamin D supplementation of refined flour, for example.

Evidence for Health Benefits of Whole Grains

Observational Studies. During the latter part of the 20th century research highlighting the benefits of consuming whole grain foods started to appear in the nutrition literature. What started as a slow realization has become a global movement supported by a steady and rapid increase in publications investigating the positive relationships between whole grain intake and improved markers of health. These studies fall into two categories—those based on observational studies (epidemiological studies) and those based on dietary interventions (13). The former continue to provide the most convincing evidence, showing strong and consistent associations between higher whole grain intake and improved indicators of health. These indicators include risk of chronic disease incidence and death from chronic diseases, as well as biomarkers of health (e.g., blood lipid profile, blood pressure, inflammatory status).

These observational studies stem from the largest long-running cohort studies and have been subjected to many systematic reviews and meta-analyses. One of the largest and most recent studies investigating all-cause, cardiovascular disease (CVD) and cancer mortality in a meta-regression analysis is that from Benisi-Kohansal et al. (3), who included data from 20 prospective cohort studies with more than 2.2 million participants covering between 5.5 and 26 years of follow-up. The results showed strong inverse associations between higher whole grain and whole grain food intakes and lower risk of all-cause mortality during follow-up in the meta-analysis. The pooled relative risk (RR) for all-cause mortality for an increase of 3 servings of total whole grain foods/day (90 g/day) was 0.83 (95% CI: 0.79, 0.88). Similar RR values were obtained for risk of mortality from CVD for total whole grain intake (RR = 0.84; 95% CI: 0.76, 0.93) and specific whole grain foods (RR = 0.82; 95% CI: 0.75, 0.90); there was a 25% lower risk of mortality from CVD for each additional 3 servings of total whole grains/day. The associations with mortality from total cancers were less strong but nonetheless significant (RR = 0.94; 95% CI: 0.91, 0.98). So many meta-analyses have been performed that an “umbrella review” was recently published by McRae (10). The study identified 21 meta-analysis studies published between 1980 and 2016 (not including the study by Benisi-Kohansal et al. [3]) that described the effects of whole grain intake on type 2 diabetes, CVD, cancer, and weight loss. Every one of the meta-analyses reported positive benefits for reducing the incidence of type 2 diabetes (RR = 0.68–0.80), CVD (RR = 0.63–0.79), and gastrointestinal cancers (RR = 0.57–0.94), with a modest effect on body weight, body fat mass, and waist

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circumference. McRae (10) did identify problems with heterogeneity, publication bias, and quality assessment among the studies. The overall conclusion from the paper was that “there is some evidence for dietary whole grain intake to be beneficial” for the diseases described and that the “findings suggest that the consumption of 2 to 3 servings per day ($\approx 45\text{g/day}$) of whole grains may be a justifiable public health goal” (10).

As with almost any scientific approach, observational research has some shortcomings. Given its nature, it does not demonstrate causality. In addition, some (mainly) older epidemiological studies failed to properly report on whole grain food versus whole grain intake. This shortcoming may be due, in part, to food composition databases that lack the appropriate information. Despite considering a number of confounders in the various analyses, it cannot be ruled out that the beneficial effects of whole grain are also partially due to healthier lifestyles, of which whole grain consumption can be a marker. Nonetheless, when taken together the observational evidence supports health benefits of whole grain in a strong and consistent manner.

Intervention Studies. One of the most commonly reported biomarkers of CVD risk is blood lipid profile, and the impact of whole grain on blood lipids has been subjected to a thorough systematic review and meta-analysis by Holl ander et al. (7). The authors screened more than 6,000 articles before including data from 24 studies published between 1988 and 2015 that met their stringent inclusion criteria for both parallel and cross-over intervention studies with apparently healthy male and female adults over the age of 18 years who were not taking statins. Studies were only included if they investigated the effects of consuming either specific whole grain foods (e.g., whole grain bread, brown rice), mixed diets high in whole grain compared with refined grain alternatives (e.g., white bread, white rice), or mixed diets devoid or low in whole grain foods. Overall the data set included data for total, LDL, and HDL cholesterol and triglyceride concentrations for up to 2,275 subjects, three orders of magnitude less than the data available from the observational studies discussed above. The results showed that when averaged across intake of all whole grains there was a small but significant reduction in LDL cholesterol of -0.09 mM (95% CI: -0.15 and -0.03 mM ; $P < 0.01$) and in total cholesterol of -0.12 mM (95% CI: -0.19 and -0.05 mM ; $P < 0.001$) compared with refined grain control. The effect was greater for oats (which contributed about 50% to the “weight” of the analysis) when considered alone, with a mean difference of -0.17 mM (95% CI: -0.25 and -0.10 mM ; $P < 0.001$) compared with refined grain control. No effects on HDL cholesterol were observed, and triglyceride concentrations only tended to be lower with whole grain intake, -0.04 mM (95% CI: -0.08 and 0.01 mM ; $P < 0.10$), compared with refined grain control. There was considerable heterogeneity in several components of the database, but this did not affect the outcome measures, although an energy-restricted diet appeared to augment the results.

The duration of intervention studies is often cited as an important factor for determining the likelihood of seeing changes in lipid profile (longer is considered better), so it is interesting that in a regression analysis duration of study appeared to be positively correlated with change in plasma cholesterol concentration (i.e., longer study duration showed less negative change from control), although this may be confounded because many of the oat studies included in the analysis were of shorter duration and resulted in the greatest reduction in plasma cholesterol concentration. The effects reported in this paper for changes in

cholesterol concentration are smaller than the weighted mean differences reported by Ye et al. (20), which may be related to the methods used to estimate the effect size in the latter study. Nevertheless, the papers demonstrate significant benefits of consuming whole grains on fasting lipid profiles and fasting glucose concentrations.

Whole Grain Dietary Guidelines and Intake

The process for developing dietary guidelines and recommendations for the population is generally similar for different countries and regions. An expert scientific committee is convened to review the available evidence for dietary requirements. For single nutrients such as a vitamin or mineral the process is relatively straightforward because the requirement can be judged against clear biochemical and/or clinical deficiency symptoms, and the expert committee can make recommendations to prevent these symptoms and achieve an identified optimal nutritional status for the nutrient. For food-based dietary guidelines the process is more complex and is most often based on evidence linking the foodstuff to disease prevention. The role of the expert committee is the same, but it must evaluate the range of data showing relationships between consumption of the foodstuff and risk of disease. As illustrated in the previous section, the evidence is sometimes inconsistent.

The consequence for whole grains is that government agencies and professional bodies have interpreted the available evidence differently, resulting in a range of dietary recommendations for whole grain foods, or possibly the absence thereof. A recent survey of 55 different countries identified 127 separate organizations, including 46 government agencies and 81 non-governmental organizations (NGOs), charities, professional bodies, the WHO, and EFSA responsible for providing nutrition guidance in these countries (14). From these 127 organizations only 48 recommendations were found. Of these, 29 were considered primary recommendations with a specific target for whole grain intake. The remaining 19 were secondary recommendations to consume whole grains in order to achieve a second (primary) target, often dietary fiber intake. The recommendations ranged from nonspecific statements (e.g., to eat more whole grains, choose whole grains where possible) to semiquantitative guidelines (e.g., to eat 3 servings of whole grains/day) to very specific quantitative recommendations (consume 75 g of whole grain/10 MJ of energy/day) (14).

The lack of consistent messages is likely to create confusion among consumers and is a problem for multinational food companies seeking to develop and market whole grain foods in different countries. Data reporting current levels of whole grain consumption are few but show that whole grain intake is very low in most countries, ranging from a little as 4 g/day for adults in Italy to around 24 g/day in the United Kingdom and 1 oz-equivalent ($\sim 20\text{ g/day}$) in the United States (9). The highest intake levels are found in Denmark and other Northern European countries where there is a stronger tradition of whole grain consumption (9). Comparing intake in different countries with the type of dietary recommendation in the country suggests no relationship and little or no change in intake over time where longitudinal data are available. For example, a whole grain intake recommendation has been in place through two revisions of the *Dietary Guidelines for Americans* (15), but whole grain intake in the U.S. adult population has barely changed over this period (2). The exception is Denmark, where whole grain intake recommendations have been supported by a strong public-private

partnership (Danish Whole Grain Campaign), resulting in significantly increased whole grain intake for the population (4). On average, Danes ate 36 g of whole grain/10 MJ/day at the start of the campaign in 2008. The implementation of the Whole Grain Campaign has resulted in an increase in the average consumption of whole grain to 63 g/10 MJ/day. This suggests that any dietary recommendation must be supported by stakeholders from government, health NGOs, and the food industry to be successful.

Identifying Whole Grains and Whole Grain Foods

Increasing whole grain intake requires that consumers be able to identify whole grain foods and have confidence in their health benefits. In the United States, the Oldways Whole Grains Council (11) administers a “Whole Grain Stamp” for labeling of whole grain products; different “stamps” are used to identify products depending on the whole grain delivered per labeled serving of the foodstuff. Whole Grain Stamps include the “100% Stamp,” which identifies products in which all of the grain ingredients are whole grain and a serving of the product delivers a minimum 16 g of whole grain. For a product bearing the “50%+ Stamp,” which was introduced in January 2017, at least half of the grain ingredients must be whole grain, and the product must deliver at least 8 g of whole grain per labeled serving. Finally, a product bearing the “Basic Stamp” must contain at least 8 g of whole grain per serving, but may also contain some refined grain. As part of the Danish Whole Grain Campaign a similar logo was developed that can be applied to foods containing whole grains, with strict criteria for different food types (5).

A definition of “whole grain” was originally proposed by AACC International (AACCI) in 1999 and subsequently modified in 2008 to allow the inclusion of malted and sprouted grains (1). This definition was adopted by the U.S. Food and Drug Administration (FDA) and formed the basis for the identification of foods that can carry the FDA approved whole grain health claim (16–18). This health claim requires that a whole grain food must contain more than 51% whole grain ingredient(s) by weight per reference amount customarily consumed. The AACCI definition of whole grain has been widely adopted, but it is only a voluntary standard outside the United States. The Healthgrain Forum proposed a modified definition of whole grain based on the AACCI definition that allows for small but inevitable losses during processing (19) and is promoting adoption of this standard in other countries. AACCI has also proposed

a definition characterizing a whole grain food as a food that “must contain 8 grams or more of whole grain per 30 grams of product” (1). This follows a similar recommendation from an academic-industry roundtable consensus statement (6). The Healthgrain Forum recently proposed a definition for whole grain foods (12) to support its definition of whole grain. This definition proposes that foods can be called whole grain on the front of food packages if the food contains more than 30% by weight whole grain and contains more whole grain than refined grain. Crucially, the proposal requires that foods labeled in this way must also comply with national requirements for food profiles that are lower in fat, sugar, and salt. The range of definitions for whole grain and whole grain foods was discussed at the 2017 Whole Grain Summit in Vienna, continuing on from similar discussions at the 2015 summit (8). Further discussion will be needed if global definitions are to be achieved to support the development of dietary recommendations and the enforcement of labeling standards. The purpose of stamps and clear labeling requirements is to provide information for consumers and to help consumers choose foods that have a higher carbohydrate quality and can be consumed as part of a healthy dietary pattern, as well as provide guidelines for food manufacturers and for the development and advertisement of new whole grain products.

The desire to offer healthy food products is motivating food manufacturers to increase the use of whole grain in cereal products. Consequently, there appears to be a continuing global trend to add whole grain claims to product labels, as indicated by the increase in the number of new product launches over time (Fig. 1). This expansion in the availability of whole grain foods is reflected in the number of foods bearing the Whole Grain Stamp, which now exceeds 120,000 different products in 58 countries worldwide (11). Given the growth in the number of whole grain foods available in the marketplace, it is disappointing to see the low levels of intake in many countries. Understanding and overcoming the barriers to whole grain consumption will be a key area for focus for public health researchers and policymakers.

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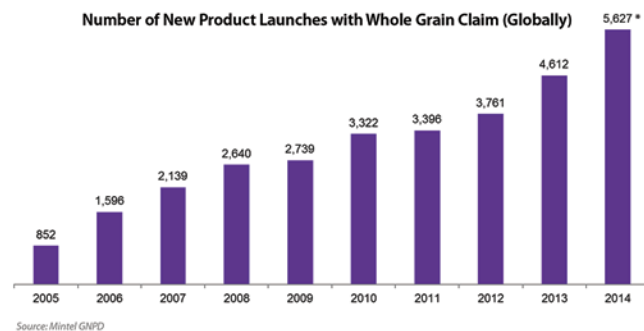


Fig. 1. Annual growth in the number of new products featuring whole grain benefit claims. * Of new food and beverage launches in 2014, 2.5% featured whole grain claims, accounting for 5,627 new product launches globally. (Figure provided courtesy of Cereal Partners Worldwide from Mintel data)

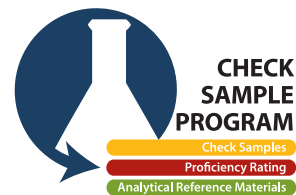
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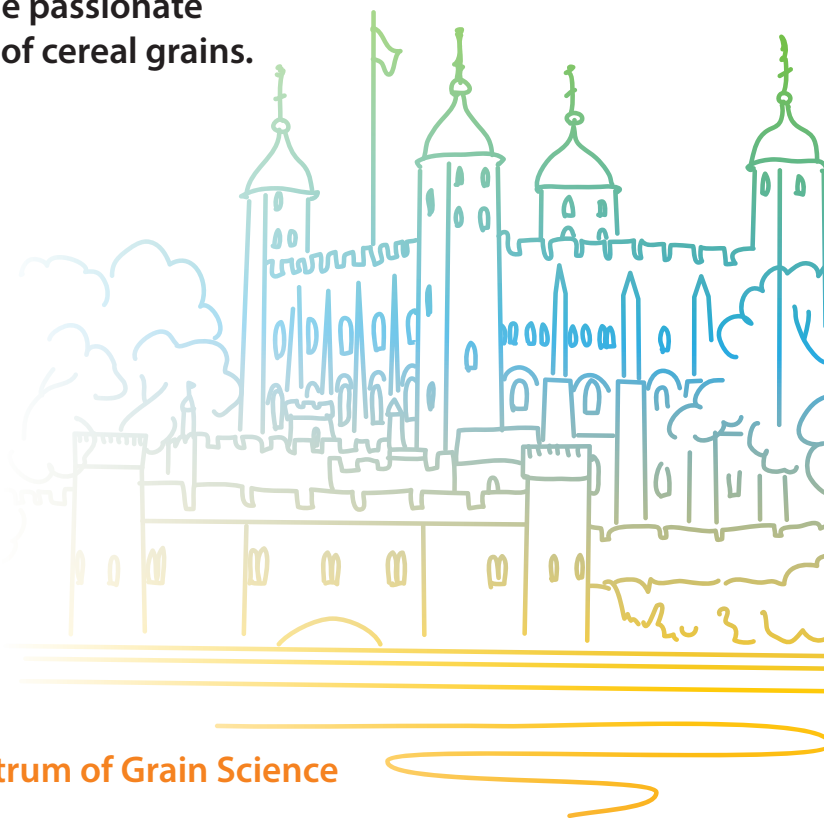
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