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NUTRINEWS

In the current issue, we look at the health benefits of whole grains.

There is a lot of evidence available that suggests protective effect of whole grain consumption against a range of chronic diseases, such as type 2 diabetes, heart diseases, and certain cancers (e.g., colorectal cancer), and their potential risk factors, such as obesity, hypertension, and elevated fasting glucose, insulin, and LDL-cholesterol concentrations.

Therefore, whole grains foods are widely recommended by health care professionals across the globe as part of a healthy diet.

In summary, this newsletter provides a recent, comprehensive scientific view on benefits of whole grain for promoting good dietary habits and healthier lifestyles.

As always, we welcome your valuable feedback and comments.

Happy reading!

Regards,
Kellogg's® Nutrition Team.

There is an increasing evidence from both observational and a few intervention studies that increased intake of less-refined, whole grain foods have positive health benefits.

Consumers with greater intakes of whole grain have consistently shown to have reduced risk of developing chronic diseases like CVD, type 2 diabetes and some cancers. Further, they are likely to have a lower BMIs and gain less weight over time. Substantial part of the evidence on the benefits of whole grain comes from observational or epidemiological studies, but evidence of benefit from interventional studies and their potential mechanisms of action is also increasing.[1]

Definitions of 'Whole Grains':

1. HEALTHGRAIN Consortium, 2010 - Whole grains shall consist of the intact, ground, cracked or flaked kernel after the removal of inedible parts such as the hull and husk. The principal anatomical components - the starchy endosperm, germ and bran - are present in the same relative proportions as they exist in the intact kernel. Small losses of components - that is, less than 2% of the grain/10% of the bran - that occur through processing methods consistent with safety and quality are allowed.[2]

2. Whole Grains Council, 2004 - Whole grains or foods made from them contain all the essential parts and naturally-occurring nutrients of the entire grain seed in their original proportions. If the grain has been processed (e.g., cracked, crushed, rolled, extruded, and/or cooked), the food product should deliver the same rich balance of nutrients that are found in the original grain seed. This means that 100% of the original kernel – all of the bran, germ, and endosperm – must be present to qualify as a whole grain.[3]

3. American Association of Cereal Chemists International (AACCI), 1999 - whole grains are "intact, ground, cracked or flaked fruit of the grain whose principal components, the starchy endosperm, germ and bran, are present in the same relative proportions as they exist in the intact grain".[4]

Health benefits of Whole Grains :

Whole grain and all-cause mortality:

Evidence from several observational cohort studies indicates inverse associations of intake of whole grains with risk of mortality from all-cause, CVD, and CHD. However, no associations with risk of deaths from stroke and diabetes were observed.[5,6]

A meta-analysis of prospective cohorts conducted by Wei H, et al.[7] in 2016 suggested an inverse relationship between increased intake of whole grain

with the risk of all-cause, CVD and cancer-specific mortality. A 19% reduction in the risk of all-cause mortality (SRR 0.81; 95% CI 0.76, 0.85), a 26% reduction in CVD mortality (SRR 0.74; 95 % CI 0.66, 0.83) and a 9% reduction in cancer mortality (SRR 0.91; 95 % CI 0.84, 0.98) was observed for each increase in 3 servings/day.

Similar findings were reported in another dose-response meta-analysis of prospective cohorts. With each additional one gram serving of whole grain consumed daily, reduction in risk for all-cause mortality and CVD-specific mortality was 7% and 8% respectively.[6]

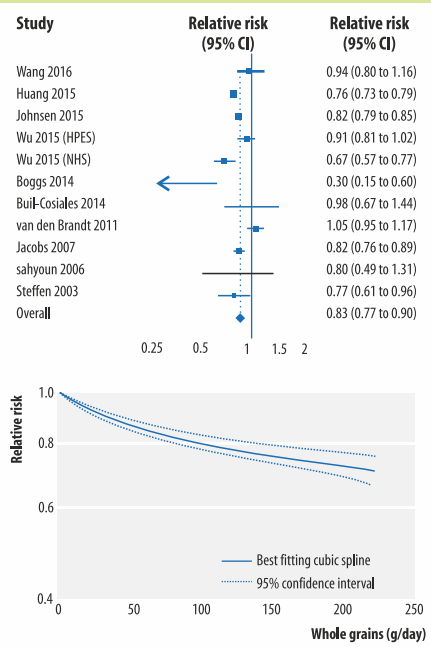

Fig 1. | Forest plot for consumption of whole grains (per 90 g/day) and risk of all cause mortality, with graps illustrating non-linear response

Another meta-analysis conducted by Chen GC, et al.[8] showed that high (compared with low) intake of whole grain or whole-grain products was significantly associated with an 11–18% lower risk of total or cause-specific mortality. When intake of whole grain products was converted to estimated grams of whole grain (assuming 16g per serving), each 50-g/d increase in whole-grain intake was associated with 22%, 30%, and 18% lower risk of dying from any cause, CVD, and cancer, respectively.

Results from a recently conducted meta-analysis of prospective cohorts indicated inverse associations of whole grain intake with total and cause-specific mortality. For each 16-g/d increase in whole grain (≈ 1 serving per day), relative risks of total, CVD, and cancer mortality were 0.93 (95% CI, 0.92–0.94; P<0.001), 0.91 (95% CI, 0.90–0.93; P<0.001), and 0.95 (95% CI, 0.94–0.96; P<0.001), respectively.[5]

Liu S, et al.[9] reported that both total mortality and CVD-specific mortality were inversely associated with whole grain but not refined-grain breakfast cereal intake in the Physicians' Health Study.

Aune D et al,[10] found that a greater whole grain intake was linked to lower risk of CHD, CVD, total cancer, and all-cause mortality, as well as mortality from respiratory disease, infectious disease, diabetes, and all non-cardiovascular, non-cancer causes. Risk reduction in all-cause mortality was 18% overall and with every 90 g/day (one serve equals to 30 g) of whole grain, 17% reduction in relative risk was observed (Fig 1).

Risk reductions were observed up to an intake of 210-225 g/day (7-7½ servings/day) of whole grains.

The results strongly support dietary recommendations to increase intake of whole grain foods in the general population to reduce risk of chronic diseases and premature mortality.

Another meta-analysis which involved 843,749 participants showed an 18% risk reduction of all-cause mortality in high whole grain consumers compared to low whole grain consumers. A dose-dependent relationship was observed which suggested that each additional 1 serving whole grain intake daily may lower the risk of all-cause mortality by 7%.[11]

Protective effect of whole grain consumption was attributed to dietary fibre, vitamins, minerals, phenolic compounds, phytoestrogens and other phytonutrients present in whole grain.[11]

Whole grain and markers of Metabolic Health:

Evidence supporting the role of whole grain consumption in improving markers of metabolic health is still emerging.

In the NDNS-RP 2008–11, a representative dietary survey of UK households it was seen that higher whole grain intake was associated with significantly lower leucocyte counts. Concentrations of C- reactive protein were significantly lower in adults in the lowest tertile of whole grain intake.[12]

On the other hand, no effect was observed with increased whole grain consumption on phenotypic or functional immune parameters, markers of inflammation or metabolic markers in a recently conducted interventional study.[13]

Hence, to be able to arrive at a conclusion on the impact of whole grain consumption on markers of metabolic health, further long term data from intervention studies are needed.

Whole grain and CVD:

There is strong epidemiological and clinical evidence linking the consumption of whole grain to a reduced risk for CHD.[14]

Large prospective epidemiological studies have

found a moderately strong association between whole grain intake and decreased CHD risk.[15]

Bruce et al. [16] fed a diet high in whole and unrefined foods as compared with a refined diet to twelve hyperlipidaemic subjects. The whole food diets significantly lowered serum cholesterol and LDL-cholesterol, improved colon function, and decreased measures of antioxidant defense, all biomarkers of decreased risk of chronic disease.

The summary RRs for high compared with low breakfast cereal intake were 0.76 (95% CI: 0.72, 0.81) for total mortality, 0.74 (95% CI: 0.64, 0.84) for CVD mortality, 0.69 (95% CI: 0.57, 0.83) for IHD mortality, and 0.92 (95% CI: 0.59, 1.42) for stroke mortality based on 2 studies.[9,17]

A prospective study conducted on a Danish cohort consisting of 54,871 adults aged 50–64 years showed significantly lower risk of myocardial infarction (MI) with higher intake of whole grain in men and women. The study further suggested that the cereals rye and oats might especially hold a beneficial effect in risk reduction.[18]

Meta-analyses of 8-14 prospective cohort studies conducted by Zong G et al. reported a 21% CVD risk reduction comparing the highest whole grain intake group with the lowest intake whole grain group.[5]

Aune D, et al [10] in a recently conducted dose-response meta-analysis found an inverse association between whole grain intake and Coronary Heart Disease (CHD), stroke and CVD. Risk reduction observed was 21%, 16% in the relative risk of CHD and CVD respectively.

A meta-analysis of prospective studies revealed that whole and refined grain consumption is not associated with total stroke risk; however, whole grain consumption is associated with reduced ischemic stroke risk.[19]

This data is supported by another dose response meta-analysis of prospective cohorts wherein the authors found no associations of whole grain consumption with risk of deaths from stroke.[6]

There is a FDA-approved health claim on labels for whole grain foods which states the following: "Diets rich in whole grain foods and other plant foods and low in total fat, saturated fat, and cholesterol, may help reduce the risk of heart disease and certain cancers." Foods using this claim must be at least 51% or more whole grains by weight and be low in fat.[20]

Whole grain and Type 2 Diabetes (T2D):

Epidemiological studies consistently show that the risk for type 2D is decreased with the consumption of whole grains. Findings of several meta-analyses conducted have found consistent inverse association to risk of T2D.[21-23]

In a meta-analysis, Ye et al.[24] investigated whole grain and fibre intake in relation to risk of T2D. They reported pooled results from 6 prospective cohorts and found that 48-80 g or 3–5 servings per day of whole grains reduced the risk of T2D by 26% (RR = 0.74 [95% CI 0.69–0.80].

Another meta-analysis conducted by Chanson-Rolle A, et al.[25] showed a statistically significant inverse association between intake of whole grain and occurrence of T2D. Further, it was estimated that consuming 45g/d (1½ servings) of whole grain ingredients would decrease the risk of T2D by 20%.

Parker ED, et al.[26] reported results from The Women's Health Initiative Observational Study, which comprised of 72,215 post-menopausal women and examined whole grain intake and risk of T2D for 7.9 follow-up years. Women who consumed >2 daily servings of whole grains reduced their risk of incident T2D by 43% compared to women who consumed none. Pereira, et al.[27] tested the hypothesis that whole grain consumption improves insulin sensitivity in overweight and obese adults. Eleven overweight or obese hyperinsulinaemic adults aged 25–56 years consumed two diets, each for 6 weeks. Fasting insulin was 10% lower during the consumption of the whole-grain diet. The authors conclude that insulin sensitivity may be an important mechanism whereby whole grain foods reduce the risk of type T2D and heart disease.[27]

Risk reduction of 21% - 32% was seen with each increment of 2-3 servings of whole grains in a meta-analysis of prospective cohorts. Further, two other meta-analyses of clinical trial results consistently documented that whole grain intake lowered fasting glucose, low-density lipoprotein cholesterol, total cholesterol, and body fat percentage.[5]

Whole grain and Body Weight:

Recent reviews have indicated inverse associations between whole grain intake and BMI, waist circumference, and weight gain among adults in epidemiological studies.

Whole grains appear to prevent weight gain among middle-aged women. In the Nurses' Health Study, a prospective cohort of US female nurses, the subjects who consumed more whole grains consistently weighed less than the women who consumed less. The women in the highest quintile of dietary fibre intake had a 49 % lower risk of major weight gain than did the women in the lowest quintile.[28]

Analysis of cross-sectional data from National Health and Nutrition Examination Survey (NHANES 2001–12) suggested that greater whole grain consumption is associated healthier body weight in children and adults. The study population consisted of children 6–18 years (n = 15,280) and adults 19+ years (n = 29,683). In both adults and children, BMI, waist circumference, % overweight and % obesity were lower in the highest whole grain consumers compared to non - whole grain consumers.[29]

Giacco et al,[30] have elucidated possible dietary mechanisms that may explain the inverse associations observed between whole grain intake and lower body weight in epidemiological studies which includes lower energy density, high volume of whole grain products and lower glycemic index (compared to refined grain foods) which may enhance satiety. Also, the relatively lower palatability of whole grain foods may promote satiation (regulation of energy intake per eating occasion through effects of hormones influenced by chewing and swallowing mechanics). Additionally, whole grains may enhance satiety (delayed return of hunger following a meal) for up to several hours following a meal.[30]

Grains rich in viscous soluble fibres like oats and barley tend to increase intraluminal viscosity prolong gastric emptying time, and slow nutrient absorption in the small intestine. Although preliminary evidence suggests that whole grains may influence body-weight regulation, additional epidemiological studies and interventional studies are needed to confirm.[15]

On the other side, there is some evidence from mostly interventional trials which doesn't support the relationship between whole grain consumption and body weight.

Epidemiological studies consistently demonstrate that higher intakes of whole grain, but not refined grains, are linked with lower BMI and/or reduced risk of obesity. However, recent clinical trials have failed to demonstrate a role for whole grain in promoting weight loss or maintenance.[32]

The results of few clinical trials do not confirm that a whole grain low-calorie diet is more effective in reducing body weight than a refined cereal diet.[30]

To conclude, the results for role of whole grain consumption on body weight are mixed. More long term, interventional trials are required to confirm the above.

Whole grain and Cancer Risk:

The relationship between whole grain intake and cancer outcomes is unclear. Subsequent prospective studies consistently found inverse associations between whole grain intake and colorectal cancer but not with other cancers.[32] Haas, et al[34] reported an inverse association between whole grain intake and colorectal cancer incidence in a meta-analysis of 25 studies.

Aune D, et al.[35] performed a dose-response analysis of 6 prospective studies and found an inverse association between whole grain food intake and colorectal cancer risk, with each 3-serving increment associated with a 17% lower risk. In a meta-analysis of prospective cohorts, epidemiological studies on whole grains and total cancer have reported mixed results, with some studies suggesting an inverse association while others have shown no clear association.[10]

Another meta-analysis showed significantly lower cancer mortality when daily whole grain consumption exceeded 30 g/d.[5]

In a recently conducted case control study, whole grain consumption of > 7 times/week was associated with reduced risk of breast cancer.[36]

A systematic review of longitudinal studies conducted recently showed no association between whole grains and cancer risk. The review suggested that the protective impact of whole grains is perhaps limited to certain types of cancer, including head and neck cancers, renal cell carcinoma, and gastrointestinal cancers.[37]

Summary of Health Benefits of Whole Grains:

Ferruzzi MG, et al tried to summarize the potential health benefits of whole grains based on available evidence (Table 1).[4]

Table 1 Summary of the potential whole-grain health benefits evidence[1,2]

Outcome	Benefits	USDA evidence analysis conclusion
CVD	Associated with ~21% lower risk of CVD	A moderate body of evidence from large prospective cohort studies shows that whole-grain intake, which includes cereal fiber, protects against CVD.
T2DM	Associated with ~26% lower risk of T2DM	Limited evidence shows that consumption of whole grains is associated with a reduced incidence of T2DM in large prospective cohort studies
Weight Management	Associated with lower BMI, Less Weight gain during 8-13y (1.27 kg), and lower central adiposity	Moderate evidence shows that intake of whole grains and grain fiber is associated with lower body weight.

[1] Conclusions are drawn from a series of meta-analyses and critical systematic reviews of whole grain in relation to health outcomes. Compared with never/rare consumers of whole grains, those consuming 2-3 servings/d of whole grains have lower risk of CVD, T2DM, and weight gain. CVD, candiovascular disease; T2DM. type 2 diabetes.
[2] The most up-to-date systematic review and meta-analysis assessing the role of whole-grain intake in developing health outcomes of interest indicate that compared with never/rare consumers of whole grains, those consuming>48g/d of whole grains have a lower risk of CVD, T2DM, and body weight gain.

Points to ponder:

Increased consumption of whole grains is encouraged principally because of its high fibre intake, as whole grain foods make an important contribution to dietary fibre intake. Choosing whole grains that are higher in fibre has additional health benefits; however, high fibre does not always equate with whole grain, just as whole grain does not always equate with high fibre.[4]

Recommendations for Whole Grain Intake:[4]

Results from large, population-based, prospective, observational studies have consistently observed a dose-dependent relation between whole grain intake and reduction of disease risk, with health benefits proportional to the amount of whole grain consumed by an individual. Current evidence shows that consuming between 3-5 servings of whole grains per day may reduce not only the risk of ischemic heart disease and CVD events but also risk factors associated with CVD. Evidence also suggests that those who consume an average of 3-5 daily servings of whole grains have a 21-30% reduction in risk of T2DM compared with those who rarely or never consume whole grains.

Global Recommendations for Whole Grain Intake.[4]

Country/organization	Specific recommendation
Australia	The Australian Dietary Guidelines and Guide to Healthy Eating recommend 3-8 ½ servings (dependent upon age, sex, or caloric requirements) of grain (cereal) foods, mostly whole grain, such as breads cereals, rice, pasta, noodles, polenta, couscous, oats, quinoa, and barley.
Australia	The Australian Food Pyramid (Die osterreichische Ernahrungspyramide) recommends consuming 4 servings/d of cereals, bread, pasta, rice, or potatoes (5 servings for active adults and children), preferably whole grains.
Canada	The Canadian Food Guide recomments 3-8 servings/d (age and sex dependent) of grain product and advises making at least one-half of the grains product choices whole grain each day. Further recommendations state to eat a variety of whole grains such as barley, brown rice, oats, quinoa, and wild rice.
Chile	Group of pediatricians in Chile from Chilean Pediatric Society recommends that one-half of grains should be whole grain to reach recommended amount of fiber.
China	The Chinese Dietary Guidelines and the Diet Pagoda recommend adults consume 300-500 g/d (dependent upon energy requirements) of total grains, cereals, and legumes, among them, at least 50 g/d of coarse grains, including whole grains.
Denmark	Denmark's Food Administration uses the Diet Compass (Kostkompasset) and the Dietary 8 (8 kostrad) to recommend consuming 75 g/d whole grains (for energy requirements of 10 MJ/d). Bread, grains, rice, and pasta should be an essential part of the diet and for older children and adults, 500 g/d is recommended.
France	France's Guide of the National Health and Nutrition Program (Guides elimentaires du program national nutrition-sante) recommends consumption of breads, cereals, and starchy foods at each meal especially whole-grain foods that provide considerable amounts of fiber.
Greece	The Dielary Guideline for adults in greece suggest consuming 8 servings of nonrefiend cereal and products, preferably whole-grain varieties (whole-grain bread, whole-grain pasta, brown rice, etc).
India	The Dietary Guidelines for Indians recommends increasing consumption of whole grains, legumes, and nuts to maintain body weight and body composition.
Latvia	The Latvian Health Ministry recommends consumption of 4-6 servings/d of cereals, especially whole grains such as fiber-rich whole-grain products (bread, pasta, oatmeal porridge) to reduce the risk of diseases.
Mexico	Mexico's Department of Nutrition and Health Promotion recommends consumption of cereals should be recommended,

	preferably whole grains without added sugar. Their fiber and nutrients should be highlighted. Whole grains should be eaten with every meal, with legume seeds.
Norway	The Health Directorate of Norway's Key Advice for a Healthy Diet (Nokkelrad for et sunt Kosthold) suggests increasing intake of whole-grain products and cereals each day. The whole-grains products should together provide 70-90 g/d of whole-meal flour or whole grains.
Oman	The Omani Guilde to Healthy Eating recommends choosing whole grains and cereals and consuming potatoes, with their skin. For an average diet of 2000 kcal, 2-3 servings/d of whole grains is advised.
Singapore	The Dietary Guidelines for adult Singaporeans and Healthy Diet Pyramid recommend eating sufficient amounts of grains especially whole grains. Out of the 5-7 sevings of rice and alternatives, adults shold consume 2-3 servings/d of whole-grain food.
Switzerland	The Swiss Society for Nutrition recommends that each main meal should be served with 1 starch-rich side dish [i.e., 3 portions/d, 1 portion + 75-125g of bread or 60-100 g of pulses (raw weight)]; for instance, lentils/chick peas or 180-300 g of potatoes or 45-75 g of pasta/rice/flakes/com/others grains (raw weight), including at least 2 portions of whole-grains products.
United Kingdom	The National Health Service's Eatwell Plate recommends eating plenty of bread, rice potatoes, pasta, and other starchy foods (shown as one-thired of a plate) and choosing whole-grain varieties whenever possible.
United States	The 2010 DGA suggests consuming 3 or more ounce-equivalents of whole-grain products per day, with rest of the recommended grains coming from enriched or whole-grain products (at the 2000 kcal intake level). Consume at least one-half of all grains as whole grains. Increase whole-grain intake by replacing refined grains with whole grains.
WHO	The WHO and the FAO of the United Nations recommend increasing consumption of whole grains as a strategy to prevent diet-related chronic diseased. The WHO/FAO rate strength of evidence for whole-grain consumption and decreased risk of CVD and diabetes as probable.

[1] CVD, cardiovascular disease; DGA, Dieatary Guidelines for Americans.

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