Health effects of whole grain: beyond coronary heart disease and diabetes

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Bran and Germ:

- 17% of weight
- 80% of fiber
- Few calories
- Has most of the biologically active compounds in the grain, lost in refining
Whole grain and cereal fiber are related but different

<table>
<thead>
<tr>
<th></th>
<th>Cereal fiber per 100 g of whole grain</th>
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</thead>
<tbody>
<tr>
<td>Rye</td>
<td>14.6 g</td>
</tr>
<tr>
<td>Wheat</td>
<td>12 g</td>
</tr>
<tr>
<td>Oats</td>
<td>10.6 g</td>
</tr>
<tr>
<td>Corn</td>
<td>7.3 g</td>
</tr>
<tr>
<td>Brown rice</td>
<td>3.5 g</td>
</tr>
<tr>
<td>Refined grain, all species</td>
<td>&lt;2 g</td>
</tr>
</tbody>
</table>
Botanical function

Endosperm:

**Nutrients**: starch-filled, poor-quality protein

**Botanical function**: supply energy to the seedling prior to roots that allow self-sustenance

Germ:

**Nutrients**: fatty acids, antioxidant compounds

**Botanical function**: plant embryo
Botanical function

**Bran:**

*Nutrients:* most of the fiber, many B-vitamins, minerals, major groups of antioxidants including several cinnamic acids, flavonoids, and tocopherols, as well as unidentified compounds.

**Bran and germ:**

*Botanical function:* signaling activation of biologic processes, preventing adverse oxidation, defense of the seedling against microorganisms.
Form of Processing

Nutritional significance of processing?

• Crushing and pulverizing to a fine flour may not cause much damage, given the microscopic size of cells.

• Cell disruption may increase digestibility.

• Intactness does improve the glycemic index (lower glucose response soon after eating, importance debated)
History

- Early 1800s: Sylvester Graham
- 1940s-1970s: Walker, Burkitt, Cleave, and Trowell
  - 337 bankers and busmen, 7 days of weighed food records, followed through 1976
  - CHD by tertile of cereal fiber: 25, 10, and 5
  - Cereal fiber tertiles were almost coincident with brown bread and strongly graded with breakfast cereal tertiles
Prospective Studies of Whole Grain Foods: Cardiovascular

Jacobs and Gallaher review, 2004, 13 studies plus 2 more recent:

* Mostly middle-aged at year 0 (two studies restricted to age ≥ 60)

* One study in Norway, 2 in Finland, 1 in England

* >520,000 men and women, followed 6-19 years

* Over 10,000 heart attacks, strokes, other cardiovascular disease, fatal or nonfatal

Relative risk for high vs. low whole grain intake:

* 0.50 – 0.86

7 studies of cereal fiber agreed
Prospective Studies of Whole Grain Foods: Progression of Atherosclerosis

- **Estrogen Replacement and Atherosclerosis trial**
  - 229 postmenopausal women
  - 3 yr decline in minimum coronary artery diameter
  - -0.10 mm for 14 sv/wk vs -0.06 mm for 3 sv/wk
    - \( P = .04 \)
  - Erkkila AT et al. Am Heart J. 2005

- **Los Angeles Atherosclerosis Study**
  - 573 men and women CVD free aged 40-60, repeated carotid wall thickness
  - Progression of wall thickness less in high vs. low fiber diet by about 18 vs 36 \(_m/3\) yr
  - Wu, Dwyer et al, AJCN. 2003
Prospective Studies of Whole Grain Foods: Congestive Heart Failure

- *Breakfast cereal intake and incident HF, 21,376 participants of the Physicians' Health Study I.*
  - 19.6 years follow-up, 1018 incident cases of HF occurred.
  - 0 vs 7 or more servings/week: , hazard ratios 0.71 (P<.001
  - Association limited to whole grain cereals
    - Djoussé, Gaziano Arch Int Med 2007
Prospective Studies of Whole Grain Foods: Diabetes Type 2

4 studies of whole grain foods

All middle-aged at year 0

1 in Finland

158,723 men and women, 6-12 years

4373 incident type 2 diabetes

Relative risk for high vs. low whole grain intake:

0.62 – 0.79
Studies of Whole Grain Foods: Noncardiovascular, noncancer, inflammatory death

- **Iowa Women’s Health Study,**
  - 27312 women free of CVD, cancer, diabetes, known inflammatory condition, 55-69 in 1986
  - followed 17 yr
- **1071 inflammatory deaths:**
  - neither cancer nor CVD,
  - causes of death selected for probable important role of inflammation, oxidative stress, and infection
    - respiratory (n=569)
    - nervous system (n=241)
    - infectious, endocrine, metabolic, digestive, musculoskeletal, genitourinary
Studies of Whole Grain Foods: Noncardiovascular, noncancer, inflammatory death

Iowa Women’s Health Study
• Graded 27% risk reduction in cardiovascular disease death as whole grain food increased

• 1071 inflammatory deaths: Risk 35% lower in habitual whole grain eaters

Studies of Whole Grain Foods: Lung Disease

- **MORGEN study**
  - 13,651 men and women aged 20-59 years cross-sectional between 1994 and 1997
  - Whole grain eaters had higher lung capacity, less COPD

- **Male Health Professionals**
  - 42,917, 40-75 y in 1986 no asthma or COPD
  - 111 incident COPD
  - 50% reduction in risk for high prudent diet score (whole grain, fruit, vegetable, fish increased)
  - Parallel unpublished finding mentioned in Nurses
  - Varosso et al. Thorax 2007
Studies of Whole Grain Foods: Inflammatory Factors

- Nurses and Health Professionals, n=938 healthy men and women, cross-sectionally whole grain eaters had lower homocysteine, insulin, C-peptide, leptin, lipids; not inflammatory markers


- Nurses, n=902, whole grain eating diabetic women had reduced CRP and tumor necrosis factor-alpha receptor 2


- Several other studies agree
  - McKeown, Lutsey, Esposito (randomized Mediterranean diet) inflammatory factors
Studies of Whole Grain Foods: Appendicitis

- 135 children (0-18 yr) with appendicitis, 212 comparison children
  - >median fiber intake 30% lower risk
  - >median whole grain foods 50% lower, especially aged 7-18
  - Brender Am J Pub Health 1985

- 203 cases (2-14 yr), 1922 controls
  - diet fiber 20.4 vs 17.4 g/d in controls vs cases (body weight and height not different)
  - Adamidis Int J Food Sci Nutr 2000

- Neither study adjusted for other behaviors
Studies of Whole Grain Foods: Gallstones

91 cholelithiasis, 86 controls
- Cholelithiasis cases less crude fiber, especially from bread and bakery products
- Smith and Gee Am J Clin Nutr 1979

1810 symptomatic gall stones in 44525 health professional men (12 yr followup)
- High refined carbohydrate, starch, simple sugars elevated risk
- Tsai Gut 2005
Studies of Whole Grain Foods: Duodenal Ulcer

- **Randomized trial**
  - 21 chronic duodenal ulcer patients on unrefined wheat diet
  - 21 usual diet in a rice-eating area
  - After 5 years only 14% of the first group had had relapses compared with 81% of controls

- 30 other patients in another area with a more varied rice diet observed for 5 years: 80% 5-year relapse rate.
- Malhotra Postgraduate Medical J 1978
Studies of Whole Grain Foods: Periodontitis

- **Periodontitis:**
  - 1897 professionally diagnosed periodontitis in 21 yr followup among 34160 male health professionals aged 40-75
  - Free of CVD, diabetes, periodontitis at baseline
  - Graded risk reduction with increasing whole grain intake, 23% reduction in risk
  - Merchant, Joshipura Am J Clin Nutr 2006

- **Desvarieux, Jacobs et al, Circulation 2005:** periodontal disease is related to CVD
Studies of Whole Grain Foods: Erectile Dysfunction

- 2 year randomized study of Mediterranean diet vs control in men with ED and metabolic syndrome
  - Mediterranean diet ate more fruits, vegetables, nuts, whole grain, and olive oil
  - Endothelial function and CRP improved
  - 37% (13/35) vs 7% (2/30) had good erectile file after 2 years
  - Esposito Int J Impot Res. 2006
Why are whole grain foods healthful?

- Long term effects may differ from the effects over only a few weeks
- **Food Synergy** – the proposition that the different natural components in food act jointly for the health of the eater, just as they act to keep the organism eaten alive
- The package of **phytochemicals** in nutrient rich plants probably acts synergistically
- Food synergy may be even stronger in food patterns, such as the “prudent diet”
Why are whole grain foods healthful?

- **The concepts of Food Synergy** and the potential power of the package of naturally occurring **phytochemicals** in nutrient-rich plants imply important novel constituents.

- **Polyphenolic compounds and particularly flavonoids** often mentioned.

  - Studies so far are tantalizing, do not predict disease as clearly as whole grains and prudent diet patterns.
Why are whole grain foods healthful?

- Whole grains are seeds which must have certain broad characteristics to support the new sprout.
- The analogy with seeds leads to tree nuts, soy, berries, chocolate, and coffee, all of which have been related to reduced risk in prospective epidemiologic studies; and spices which have some of the most obvious polyphenols, at least in terms of sensory qualities.
No one cultural sector can be very far out of step from the others; each can facilitate change in the others