Cereal Foods and Health
New results and science-based nutrition guidelines

INTRODUCTION

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Overweight
– a growing European problem

Percentage of males overweight
(BMI ≥25) 2010

WHO Global Database on Body Mass Index 2010
Diabetes
– growing national prevalence

2011

2030

< 6%  > 6%  > 8%  > 10%  > 12%  > 15%

The main cause of death in the EU is Cardiovascular disease (CVD)

- Coronary heart disease (CHD) and stroke are the main forms of CVD
- 45% deaths in women and 38% of deaths in men stem from CVD

Source: European Cardiovascular Disease Statistics (2008)
Colorectal cancer is the second most common cause of cancer death in both men and women!

Estimated age-standardized incidence rates per 100,000 of colorectal cancer in 2008

Source: European Cancer Observatory 2008
This worldwide epidemic of non-communicable diseases goes in parallel with dramatic lifestyle changes; among them modifications of the habitual diet at the population level play a relevant role.
Foods available for consumption over time in Northern European Countries

Meat (g/day)
Foods available for consumption over time in Northern European Countries

Cereals (g/day)

- Austria
- Belgium
- Denmark
- Finland
- Germany
- Ireland
- Norway
- Netherlands
- United Kingdom
- Sweden
The wheat grain kernel and its composition

- The kernel has 3 major parts:
  - Bran
  - Germ
  - Starchy Endosperm

- Whole grain flour contains 100% of the original germ and bran

- Bran and germ have a high content of fibre, micronutrients (vitamins, minerals, trace-elements) and bioactive plant compounds (antioxidants, sterols, etc).

What is whole grain?

A food is “made with whole grain” when the grain components (starchy endosperm, germ and bran) are present in the same relative proportions as in the original intact grain kernel.

Source: HEALTHGRAIN definition:
http://www.healthgrain.org/regulatory_issues
# The Probability of Developing Obesity Is Generally Lower with Larger Intakes of Dietary Fiber and Whole Grains (1 = parity)

<table>
<thead>
<tr>
<th>Incremental consumption</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
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</thead>
<tbody>
<tr>
<td><strong>Refined grain</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Odds ratio BMI ≥ 30</td>
<td>1.00</td>
<td>0.97</td>
<td>0.96</td>
<td>1.03</td>
<td>1.21</td>
</tr>
<tr>
<td><strong>Whole grain</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Odds ratio BMI ≥ 30</td>
<td>1.00</td>
<td>0.97</td>
<td>0.90</td>
<td>0.86</td>
<td>0.85</td>
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<tr>
<td><strong>Dietary fibre</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Odds ratio BMI ≥ 30</td>
<td>1.00</td>
<td>0.81</td>
<td>0.72</td>
<td>0.73</td>
<td>0.61</td>
</tr>
</tbody>
</table>

Modified from: Liu S et al, Am J Clin Nutr 2003; Relation between changes in intakes of dietary fiber and grain products and development of obesity among middle-aged women (NHS)
THE RISK OF DIABETES DECREASES WITH INCREASED WHOLE GRAIN CONSUMPTION (1 = parity)

Multivariate-Adjusted RR of Type 2 Diabetes for a Two-Servings-per-Day Increment in Whole Grain Intake
THE PROBABILITY OF CVD DECREASES WITH INCREASED WHOLE GRAIN CONSUMPTION (1 = parity)

Figure 1  Odds ratios of incident cardiovascular disease, comparing high versus low whole grain intake.

Mellen FB, NMCD 2007
A high intake of dietary fibre, in particular from cereals and whole grains, is associated with a reduced risk of colorectal cancer.

Systematic review and meta-analysis of prospective observational studies suggest:

- 10% reduction in risk of colorectal cancer for each 10g/day intake of total dietary fibre and cereal fibre
- 20% reduction for each three servings (90g/day) of whole grains daily
- Further reductions with higher intake.
Whole grain foods for the prevention of type 2 diabetes mellitus (Review)

Priebe MG, van Binsbergen JJ, de Vos R, Vonk RJ
Whole grain foods for the prevention of type 2 diabetes mellitus (Review)

• Properly designed long-term randomised controlled trials are needed.
The food constituent is not sufficiently characterised:

- whole grain foods (including whole grain flour) are defined differently across countries, also within the EU.

- whole grain refers to foods and food constituents derived from different cereals: rice, barley, wheat, oat, rye; they differ for their nutrient composition and have been shown to induce different effects on relevant physiological functions
A cause and effect relationship cannot be established:

different health outcomes have been evaluated (most of them can be considered as “beneficial”): “gut health”/“bowel function”, “weight control”, “blood glucose”/“insulin levels”, “weight management”, “blood cholesterol”, “satiety”, “glycaemic index”, “digestive function” and “cardiovascular health”;

however, each intervention study on a specific outcome used a different definition of (and therefore a different intervention with) whole grain foods.
Clinical trials on whole grain and risk of type 2 diabetes

Are all the available markers of health outcomes equally appropriate?
Randomized control trials

Effects of rye and whole wheat versus refined cereal foods on metabolic risk factors: A randomised controlled two-centre intervention study

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Study design

Control Diet (Refined cereals - high GI) N=61

Experimental Diet (Wholegrain cereals - low GI) N=62

Randomization (4 wk)

7-day food record

0 4 wk 8 wk 12 wk

7-day food record

Anthropometry Biochemistry Blood pressure

FSIVGTT

Test meal (Refined Cereals)

24h Urinary Isoprostanes

Anthropometry Biochemistry Blood pressure

FSIVGTT

Test meal (Refined or Whole grain cereals)

24h Urinary Isoprostanes

AT needle biopsy
Wholegrain cereal food consumption compared with refined cereals for 12 weeks did not affect peripheral insulin sensitivity.

<table>
<thead>
<tr>
<th></th>
<th>Control group (n = 54)</th>
<th>Wholegrain group (n = 57)</th>
<th>p for Δ</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>12 Week</td>
<td>Δ (%)</td>
</tr>
<tr>
<td>$S_1$</td>
<td>3.32 ± 0.26$^b$</td>
<td>3.18 ± 0.22</td>
<td>-4.2$^c$ (-18; +5)$^d$</td>
</tr>
<tr>
<td>QUICKI</td>
<td>0.37 ± 0.006</td>
<td>0.36 ± 0.006</td>
<td>-1.39 (-2.6; -0.2)</td>
</tr>
<tr>
<td>DI</td>
<td>146 ± 17</td>
<td>160 ± 21</td>
<td>+9.6 (-14; +24)</td>
</tr>
<tr>
<td>dAIRg (2–10 min)</td>
<td>542 ± 5.2</td>
<td>557 ± 5.4</td>
<td>+2.8 (-8.2; +10.4)</td>
</tr>
</tbody>
</table>

Giacco R et al, Clinical Nutrition 2013
Wholegrain cereal food consumption compared with refined cereals for 12 weeks improved post-prandial insulin sensitivity

**Control group (n=26)**

**Wholegrain group (n=28)**

ANOVA *p=0.04 Changes (3 months- Run-in) in mean plasma insulin for 2 hrs postprandial increments between experimental and control diets
Factors influencing post-prandial blood glucose rise

Cereal foods

Stomach

Gastric emptying

Small intestine

Liver

GUT

Food features:
- macro/micro-nutrient composition
- amount and properties of fibre
- food structure

Disruption/digestion

Plasma glucose

Short chain fatty acids
Methods for the evaluation of insulin sensitivity in different organs

• **Muscles/adipose tissue:**
  - euglycemic clamp, FSIVGTT, HOMA

• **Gut/liver:**
  - OGGT, Meal test, hepatic glucose clearance/production
TAKE HOME MESSAGES

• The epidemiological association between a higher intake of whole grain and a lower risk of overweight, cardiovascular diseases and diabetes is strong and consistent.

• Different biological mechanisms that might explain this association have been elucidated.

• Controlled intervention studies are needed to investigate whether an increased intake of whole grain cereals contributes to the prevention of overweight, diabetes, cardiovascular diseases.
TAKE HOME MESSAGES

Methodological issues relevant for designing intervention studies on the health benefits of whole grain

• Prevention vs treatment
• Study duration and sample size
• Markers of functions/end-points
• One cereal type vs multi-grain
• Real life approach vs excessive constraints