Whole Grain Wheat Intake – Impact on Weight Loss, Body Composition and Cardiometabolic Factors: 
*Results from Intervention Studies*

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Outline

- Global obesity rates
- Whole grain wheat intervention studies and cardiometabolic risk factors
- Penn State studies
  - Katcher et al., 2008
  - Harris et al., 2013
- Summary
Overweight Rates

BMI ≥ 25 - 29.9
Key facts

• Worldwide obesity has nearly doubled since 1980.
  • In 2008, > 1.4 billion adults, ≥ 20 yrs were overweight.
    200 million men and nearly 300 million women were obese.
• 35% of adults ≥ 20 yrs were overweight in 2008; 11% were obese.
• 65% of the world's population live in countries where overweight and obesity kills more people than underweight.
• More than 40 million children under the age of five were overweight in 2011.
Three Reviews (2011 to 2013)
Role of Whole Grains in Body Weight Regulation

• Whole grain and body weight changes in apparently healthy adults: a systematic review and meta-analysis of randomized controlled studies.

• The role of whole grains in body weight regulation.

• Whole grain intake in relation to body weight: from epidemiological evidence to clinical trials.
Conclusions of Clinical Studies
Whole Grains and Body Weight Regulation

• Whole-grain consumption does not decrease body weight compared to the control, but there may be a small beneficial effect on body fat.

• Epidemiological studies consistently demonstrate that higher intakes of WG, but not RG, are associated with lower BMI and/or reduced risk of obesity. However, recent clinical trials have failed to support a role for WG in promoting weight loss or maintenance.

• 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.
Whole grains and change in body weight

Whole grains and change in body fat percentage

Whole grains and change in waist circumference

Whole Grain Compared with Refined Wheat Decreases the Percentage of Body Fat

• 79 overweight/obese postmenopausal women
• Randomized to one of two, 12-Week, energy-restricted diets (deficit of ~1250 kJ/d [300 kcal])
  – Refined wheat diet = 0 g/d whole grains (n=34)
  – Whole wheat diet = 105 g/d whole grains (n=38)

Body weight decreased significantly from baseline in both the RW (−2.7 ± 1.9 kg) and WW (−3.6 ± 3.2 kg) groups, but the decreases did not differ between the groups (P = 0.11). The reduction in body fat percentage was greater in the WW group (−3.0%) than in the RW group (−2.1%) (P = 0.04).

Controlled Clinical Studies Conducted at Penn State Designed to Evaluate the Effects of Whole Grains on Weight Loss and CVD Risk Factors

Clinical study conducted with free-living participants on self-selected weight loss diets with whole grains versus refined grains – Katcher et al., AJCN 2008;87:70-90.

Controlled feeding study conducted with participants fed whole grain versus refined grain weight loss diets – Harris et al., manuscript in preparation.
The effects of a whole grain–enriched hypocaloric diet on cardiovascular disease risk factors in men and women with metabolic syndrome


**Conclusions:** Both hypocaloric diets were effective means of improving CVD risk factors with moderate weight loss. There were significantly (P < 0.05) greater decreases in CRP and percentage body fat in the abdominal region in participants consuming whole grains than in those consuming refined grains.
50 men and women with metabolic syndrome

Age 20-65

All grains from refined grains

12 weeks

Assess weight loss and cardiovascular risk factors

All grains from whole grains (4-7 servings/d)

12 weeks

Study Design
Parallel Design with Subjects on Self-Selected Diets
Both Groups Complied with Whole Grain Recommendations

* $P < 0.001$ difference between groups. Values are mean $\pm$ SE.
Body Weight Decrease in Both Groups

No significant difference between groups in weight loss at any time point
Improvements in Other Endpoints

<table>
<thead>
<tr>
<th></th>
<th>Systolic BP (mmHg)</th>
<th>Diastolic BP (mmHg)</th>
<th>Waist Circ (cm)</th>
<th>Abdominal body fat (%)</th>
<th>Body Fat (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change</td>
<td>Whole Grain</td>
<td>Refined Grain</td>
<td>Whole Grain</td>
<td>Refined Grain</td>
<td>Whole Grain</td>
</tr>
<tr>
<td></td>
<td>P=0.06</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>P&lt;0.001</td>
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</table>
c-Reactive Protein Decreased in the Whole Grain Group Only

* $P = 0.007$ different between groups. Values are mean ± SE.
No Significant Change in Glucose after OGTT

Values are mean ± SE
Summary of Katcher et al. 2008 Study

• No significant difference in weight loss between a whole grain and refined grain diet

• Greater reduction in C-reactive protein in participants in the whole grain group

• No significant differences between groups in change in lipids and lipoproteins or glucose tolerance

• Greater decrease in abdominal fat with whole grains
Effects of Whole and Refined Grain Weight Loss Diets on Cardiometabolic Risk Factors Including Abdominal Adipose Tissue Depots

Kristina A. Harris
Sheila G. West, Jack P. Vanden Heuvel, Satya Jonnalagadda, Alastair Ross, Alison Hill, Jessica Grieger, and Penny M. Kris-Etherton
Main Study Hypothesis

A diet rich in whole grains will elicit greater improvements in cardiometabolic risk factors than a diet rich in refined grains.

Secondary Study Hypothesis

A diet rich in whole grains will elicit a greater decrease in visceral adipose tissue than a diet rich in refined grains.
Primary Study Population Characteristics

- 24 males and 25 females, ages 35-55
  - 28 (12 RG, 16 WG) participated in MRI analysis
- BMI 25-42 kg/m²
- Increased waist circumference + ≥1 Metabolic Syndrome criteria
- Generally healthy
- Non-smokers, not taking cholesterol or glucose medications
Whole grain menu: Higher in fiber and magnesium

<table>
<thead>
<tr>
<th></th>
<th>Refined Grain</th>
<th>Whole Grain</th>
</tr>
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<tbody>
<tr>
<td>Total Energy (kcal)</td>
<td>2023</td>
<td>2079</td>
</tr>
<tr>
<td>WG Servings [g WG]</td>
<td>0 [0]</td>
<td>7 [112]</td>
</tr>
<tr>
<td>Carbohydrate (g, [% kcal])</td>
<td>280 [55]</td>
<td>299 [57]</td>
</tr>
<tr>
<td>Protein (g, [% kcal])</td>
<td>90 [17]</td>
<td>97 [18]</td>
</tr>
<tr>
<td>Fat (g, [% kcal])</td>
<td>64 [28]</td>
<td>62</td>
</tr>
<tr>
<td>Total Fiber (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soluble Fiber (g)</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Insoluble Fiber (g)</td>
<td>7.5</td>
<td>16</td>
</tr>
<tr>
<td>Sugars (g)</td>
<td>100</td>
<td>114</td>
</tr>
<tr>
<td>Magnesium (mg)</td>
<td>262</td>
<td>411</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>1031</td>
<td>1491</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>4026</td>
<td>3928</td>
</tr>
<tr>
<td>Potassium (mg)</td>
<td>3028</td>
<td>3445</td>
</tr>
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Markers of MetS improved in both treatment groups; Glucose decreased more on whole grain diet

<table>
<thead>
<tr>
<th></th>
<th>Refined Grain</th>
<th>Whole Grain</th>
<th>P-value</th>
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<tbody>
<tr>
<td><strong>Mean ± SEM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>-1.5 ± 0.2</td>
<td>-1.7 ± 0.2</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Waist Circumference (cm)</strong></td>
<td>-3.7 ± 0.7</td>
<td>-2.5 ± 0.7</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Body fat (%)</strong></td>
<td>-1.0 ± 0.2</td>
<td>-0.8 ± 0.2</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Abdominal fat (%)</strong></td>
<td>-1.2 ± 0.4</td>
<td>-1.5 ± 0.4</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Systolic blood pressure (mmHg)</strong></td>
<td>-8.8 ± 1.7</td>
<td>-7.6 ± 1.7</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Diastolic blood pressure (mmHg)</strong></td>
<td>-5.2 ± 1.2</td>
<td>-3.2 ± 1.2</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Fasting Glucose (mg/dL)</strong></td>
<td>-1.2 ± 1.0</td>
<td>-4.0 ± 1.0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td><strong>Fasting Insulin (mIU/mL)</strong></td>
<td>-1.0 ± 0.5</td>
<td>-1.1 ± 0.6</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>HOMA-IR</strong></td>
<td>-0.4 ± 0.1</td>
<td>-0.5 ± 0.1</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>HDL-C (mg/dL)</strong></td>
<td>-2.7 ± 0.8</td>
<td>-5.0 ± 0.8</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>Triglycerides (mg/dL)</strong></td>
<td>-15 ± 8.7</td>
<td>-4 ± 8.6</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>CRP (mg/L)</strong></td>
<td>-0.9 ± 3.6</td>
<td>-0.7 ± 0.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Least-squared means and p-value from model for total change (BL-HYPO) differences between groups, while controlling for baseline values, age, and sex.
No significant difference in weight loss between groups.
No significant difference in % abdominal fat loss between groups.
Subcutaneous vs. Visceral Fat
Visceral Fat was significantly reduced on the Whole Grain Diet but was not different from the Control.
Greater Increase in the Biomarker of Whole Grains Correlated with a Greater Reduction in Visceral Fat

Subcutaneous: $r=0.15$, $P=0.46$  
Visceral: $R=-0.48$, $P=0.01$
Visceral Fat Correlated with Insulin at Baseline

**Subcutaneous**
- BMI ($r=0.63$)
- Waist circumference ($r=0.62$)
- Total fat ($r=0.71$)
- Trunk fat ($r=0.63$)
- Abdominal fat ($r=0.71$)
- CRP ($r=0.57$)
- IL6 ($r=0.63$)
- Leptin ($r=0.57$)

**Visceral**
- Trunk fat ($r=0.42$)
- Resting metabolic rate ($r=0.40$)
- Insulin ($r=0.37$)
- HOMA ($r=0.39$)

Spearman rank sum correlations, $P<0.05$
Only Changes in Insulin Correlated with Changes in Visceral Fat

△ Subcutaneous

- △ Weight ($r=0.59$)
- △ BMI ($r=0.61$)
- △ Total fat ($r=0.41$)
- △ Trunk fat ($r=0.46$)
- △ Abdominal fat ($r=0.44$)
- △ Triglycerides ($r=0.42$)

△ Visceral

- △ Insulin ($r=0.39$)

Spearman rank sum correlations, $P<0.05$
• This subgroup analysis suggests that whole grains may reduce visceral fat during weight loss more than refined grains.

• Changes in visceral fat are associated directly with changes in fasting insulin.

• In an at-risk overweight population, most surrogate markers of abdominal adipose tissue (waist circumference, % fat from DXA) correlated with subcutaneous but not visceral fat.
Possible Mechanisms of Action for Whole Grain Effects

• There is some evidence from clinical studies that whole grain consumption has a small beneficial effect on body fat, and possibly visceral adipose tissue.

• Future studies are needed to evaluate the effects of whole grains on body composition and the underlying mechanisms.
Thank You!
Enjoy Whole Grains!