Global Burden of Diabetes

• At least 285 million people have type 2 diabetes worldwide, and the number is expected to reach 438 million by the year 2030, with two thirds of cases in low- to middle-income countries (LMIC) (IDF).

• The number of adults with impaired glucose tolerance (IGT) will rise from 344 million in 2010 to 472 million in the year 2030.

• Type 2 diabetes used to be called adult-onset diabetes, since it was almost unheard of in children. But with the rising rates of childhood obesity, it has become more common in youth, especially among certain ethnic groups.

• The global health expenditure on diabetes is expected to total at least $376 billion in 2010 and increase to $490 billion in 2030. Globally, diabetes account for 12% of the health expenditures in 2010 (Zhang P Diabetes Res Clin Pract; 2010).
Diagrammatic representation of increase in diabetes prevalence in different populations of the world

Bhattarai 2010
Escalating diabetes Epidemic in China

Yang et al. NEJM 2010
Diabetes Among Japanese-Brazilians

Relative Risk of Type 2 Diabetes Adjusted for BMI & Dietary & Lifestyle Variables

<table>
<thead>
<tr>
<th></th>
<th>Relative Risk</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>2.26</td>
<td>(1.70-2.99)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1.86</td>
<td>(1.40-2.47)</td>
</tr>
<tr>
<td>African-American</td>
<td>1.34</td>
<td>(1.12-1.61)</td>
</tr>
</tbody>
</table>

(Shai I, Diabetes Care 2006)
Increased risk of diabetes according to an unhealthy dietary pattern: high GL, low fiber, low PUFA, and high trans fat

(Shai et al., Diabetes Care, 2006)
A PIPELINE OF DISEASE—AND ESCALATING COSTS

kidney disease
10-20% of people with diabetes die of kidney failure

eye disease
After 15 years of diabetes, 2% of persons go blind; 10% develop severe visual impairment.

heart disease & stroke
70% of people with diabetes die of heart attack or stroke

nerve disease
Diabetic nerve disease affects up to 50% of people with diabetes, and when combined with reduced circulation in the legs increases risk of foot ulcers and limb amputation

15–25 years

In 2005, 1.1 to 2.9 million people died of diabetes or its complications
Expected to double by 2030 to 360 million

5–10 years
diabetes

More than 180 million people worldwide had diabetes in 2008
Expected to increase to 2.3 billion overweight and 700 million obese by 2015

5 years

obesity

At least 1.6 billion people age 15 and older were overweight and 400 million were obese in 2005

0 years

overweight

Harvard Public Health Review
“Cancer, diabetes, heart diseases are no longer the diseases of the wealthy. Today, they hamper the people and the economies of the poorest populations, even more than infectious diseases. This represents a public health emergency in slow motion.”

Mr Ban Ki-Moon, UN Secretary-General
Body mass index

Population attributable risk = 60%

Hu et al. NEJM 2001
Waist Circumference and Diabetes

Compiled from Nurses Health Study (women); Health Professional Followup Study (men)
Physical activity and sedentary lifestyle and diabetes risk in the NHS

- TV watching (2hrs/d): 14%
- Sitting at work (2hrs/d): 7%
- Other sitting (2hrs/d): 9%
- Standing at work (2hrs/d): 3%
- Household chores (2hrs/d): -12%
- Brisk walking (1hr/d): -34%

(Hu JAMA 2003)
Hu et al. NEJM 2001; 345:790-797
Relative Risk of NIDDM by Different Levels of Cereal Fiber and Glycemic Load

Cereal fiber

Salmeron et al, 1997

Relative Risk

<table>
<thead>
<tr>
<th>Glycemic Load</th>
<th>High (&gt;5.8 g/day)</th>
<th>Medium (2.5 -5.8 g/day)</th>
<th>Low (&lt;2.5 g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (&gt;165)</td>
<td>1.51</td>
<td>2.17</td>
<td>2.5</td>
</tr>
<tr>
<td>Medium</td>
<td>1.28</td>
<td>1.8</td>
<td>2.3</td>
</tr>
<tr>
<td>Low (≤143)</td>
<td>1 (ref)</td>
<td>1.62</td>
<td>2.05</td>
</tr>
</tbody>
</table>
High GL diets increase risk of diabetes in pregnancy
Gestational diabetes over 8 y of follow up in 13,110 women

Zhang et al. Diabetes Care 2006
White Rice Intake and Risk of Diabetes in Shanghai Women

Results: substituting 50 gram/day brown rice for white rice

Qi et al. Arch Intern Medicine 2010
Test for interaction, P<0.01

Multivariate Relative Risk of CHD by Body Mass Index and Glycemic Load

Liu, AJCN 1998
**TCF7L2, dietary carbohydrate quality and risk of T2D**

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Glycemic Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>GG</td>
<td>1.00</td>
</tr>
<tr>
<td>GT</td>
<td>1.06 (0.77-1.47)</td>
</tr>
<tr>
<td>TT</td>
<td>1.66 (0.95-2.88)</td>
</tr>
<tr>
<td>Additive</td>
<td>1.19 (0.94-1.51)</td>
</tr>
</tbody>
</table>

adjusted for age, BMI, smoking, alcohol, coffee, menopausal status, physical activity, P:S ratio, *trans*-fat, and cereal fiber intake

P=0.03 for interaction

Cornelis et al. AJCN 2009
Dietary Patterns

**Western dietary pattern**
*Red meat, processed meat, refined grain, high fat dairy, high sugar drink*

**Prudent dietary pattern**
*Vegetable, fruits, whole grains, and fish*
Joint analysis: Genetic Risk Score (GRS) and Western dietary pattern

![Bar chart showing odds ratio with GRS categories (Low, Median, High)]

- **GRS**
  - High, >12
  - Median, 10-11
  - Low, <10

2.75-folds high risk

Qi et al. AJCN 2009
Sugar-Sweetened Soft Drinks and Type 2 Diabetes, NHS2 1991-1998

Sugar-sweetened soft drink consumption

Relative Risk

P<0.001 for trend

<1/mo 1-4/mo 2-6/wk >=1/d

P<0.001 for trend

Schulze et al. JAMA 2004
Original Contribution

Soft Drink and Juice Consumption and Risk of Physician-diagnosed Incident Type 2 Diabetes

The Singapore Chinese Health Study

Andrew O. Odegaard*, Woon-Puay Koh, Kazuko Arakawa, Mimi C. Yu, and Mark A. Pereira

Figure 1. Mean weight change by soft drink intake category in the Singapore Chinese Health Study, 1993-2004. Results were adjusted for age, sex, dialect, year of interview, person-years, education, smoking, alcohol, body mass index, and total intakes (g/day) of fruits, vegetables, dairy products, meat, candy, and desserts, as well as dietary fiber, saturated fat, juice, and coffee. Bars represent the standard error of the estimated mean weight change between the baseline and follow-up interviews. The mean follow-up time was 5.7 years.
Potential biological mechanisms underlying the effect of SSBs on weight gain, and Cardiometabolic disease risk

SSB

- Liquid Calories
- High GL
- Fructose

Weight gain
Insulin Resistance
β-cell dysfunction
Inflammation
Hypertension
Visceral adiposity
Atherogenic Dyslipidemia

Met Syn
T2DM
CHD

Malik et al. Circulation 2010
Coffee Consumption and Type 2 Diabetes

Relative Risk

- Men
  - p for trend = 0.002 for men

- Women
  - p for trend = <0.001 for women

Salazar-Martinez
2004 Ann Int Med
Chlorogenic acid?

- May reduce glucose uptake and stimulate beneficial gut hormone secretion in humans (glucagon-like-peptide-1) 
  *(Johnston KL et al, 2003)*

- May reduce glucose output of liver cells 
  *(Arion WJ et al, 1997)*

- May have beneficial antioxidant effects

- Several other potential contributors: lignans, magnesium, trigonelline, other antioxidants, combinations of components (interactions)!
Risk of Diabetes in Low Risk Groups In the Nurses’ Health Study, 1980-1996

### FIVE LOW-RISK FACTORS
1. Diet score in upper 2 quintiles
2. BMI<25
3. Moderate to vigorous exercise ≥30 min/day
4. Nonsmoking
5. Alcohol (half drink to 1 drink per day)

<table>
<thead>
<tr>
<th>Percentage of Women in Group</th>
<th>No. of diabetes Events</th>
<th>Relative Risk (95%CI)</th>
<th>Population Attributable Risk (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.9</td>
<td>12</td>
<td>0.10 (0.06-0.17)</td>
<td>90% (82-94)</td>
</tr>
</tbody>
</table>

Hu et al. NEJM 2001
Diabetes Lifestyle Intervention Trials

- Da Qing Diabetes Study (42% ↓)
- Finnish Diabetes Prevention Study (58% ↓)
- US Diabetes Prevention Program (58% ↓)
- The Indian Diabetes Prevention Program (29% ↓)
The long-term effect of lifestyle interventions to prevent diabetes in the China Da Qing Diabetes Prevention Study: a 20-year follow-up study

Guanwei Li, Ping Zhang, Jingjing Wang, Edward W. Gregg, Wenyong Yang, Qihong Gao, Hui Li, Hongliana Li, Yayan Jiang, Yali An, Ying Shu, Bo Zhang, Jingling Zhang, Theodore J. Thompson, Robert B. Gerzof, Gojka Roglic, Yinghua Hu, Peter H. Bennett

**Figure 2:** Cumulative incidence of diabetes mellitus during follow-up in China Da Qing Diabetes Prevention Outcome Study

6-year intervention hazard rate ratio 0.49 (95% CI 0.33–0.73)
20-year follow-up hazard rate ratio 0.57 (95% CI 0.41–0.81)
Incidence of Diabetes during Follow-up, According to the Success Score

Finnish Diabetes Prevention Study

Tuomilehto 2001 NEJM
Summary

• Prevalence of diabetes is rising globally and threatens to overwhelm health systems in low and middle-income countries.

• “Diabetes is a development issue — the epicentres of the epidemic are in low- and middle-income countries and it is a threat to the health and economic prosperity of nations” (IDF).

• The majority of type 2 diabetes cases can be prevented through diet and lifestyle modification and the same changes can have many other health benefits.

• The adoption of a healthy diet and lifestyle requires both individual behavioral changes and changes in our food and built environment.