



# Food Matters: A Clinical and Public Health Framework

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# Guiding Rationale for Food Matters



Humans must eat; what we eat matters;  
it profoundly affects our health

What we eat depends in large part on  
the system that produces our food



# Guiding Rationale for Food Matters



- The food system is especially important to the health of pregnant women, infants, children, and adolescents
- Developing humans are uniquely vulnerable to sub-optimal nutrition and toxic environmental exposures,
- These can have lifelong consequences



# The dominant industrialized food system



- Produces large quantities of calorie-rich, nutrient-poor food
- Is a major driver of obesity, diabetes, cardiovascular disease, some kinds of cancer, malnutrition, and other chronic diseases
- Depends on extensive inputs; fuels, fertilizers, pesticides, chemical additives, packaging, etc
- Contributes significantly to environmental degradation, including air and water pollution, climate change, and loss of biodiversity
- Is a source of exposure to environmental contaminants and other chemicals

# Questions to consider



What are the responsibilities of the healthcare sector to address the nutritional and environmental origins of the diseases treated by its members and organizations?

What role can the healthcare sector play in reversing the epidemics of today, and envisioning a healthier future?



# Public Health Impact of Environmentally-Driven Disease is Profound



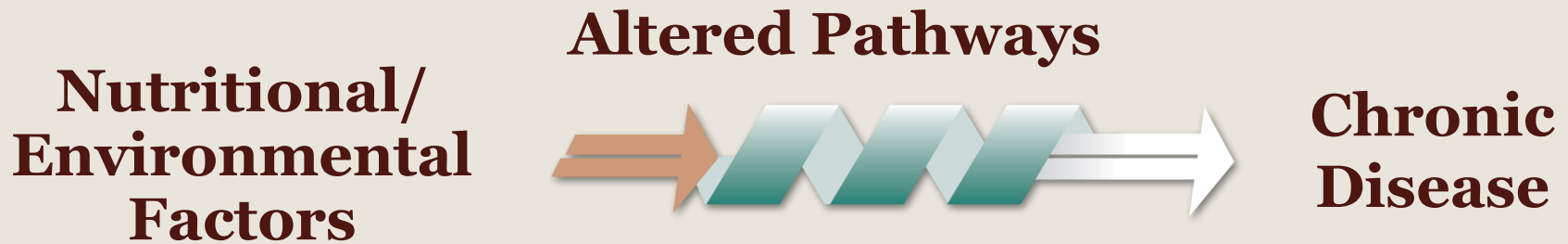
- **Obesity/overweight**
  - 2/3 US adults, prevalence X2 in ~25 yrs
- **Pre/Diabetes**
  - 40% US adults. Prevalence DM ~X2 over 20 yrs
- **Cardiovascular disease**
  - Still leading cause of death
- **Metabolic syndrome**
  - Early signs of other cluster diseases; 35% adults, ~55% >60 yrs
  - Metabolic syndrome in childhood increases the risk of cardiovascular disease in adulthood 15 fold

# An Ecological Health Framework:

The individual in the context of family, community, society and ecosystem



# Food Environments Drive Chronic Disease



## Mechanisms of Action

Inflammation  
Disrupted Insulin Signaling  
Oxidative Stress

# Inflammation



Inflammation is a dimension of:

- Diabetes
- Metabolic syndrome
- Obesity
- CVD
- Some neurodegenerative disorders
- Various kinds of cancer
- Other chronic illnesses

# Oxidative Stress



## INTERNAL

Mitochondria  
Activated Immune Cells  
(phagocytes)

Reactive Oxygen  
Species  
(ROS)

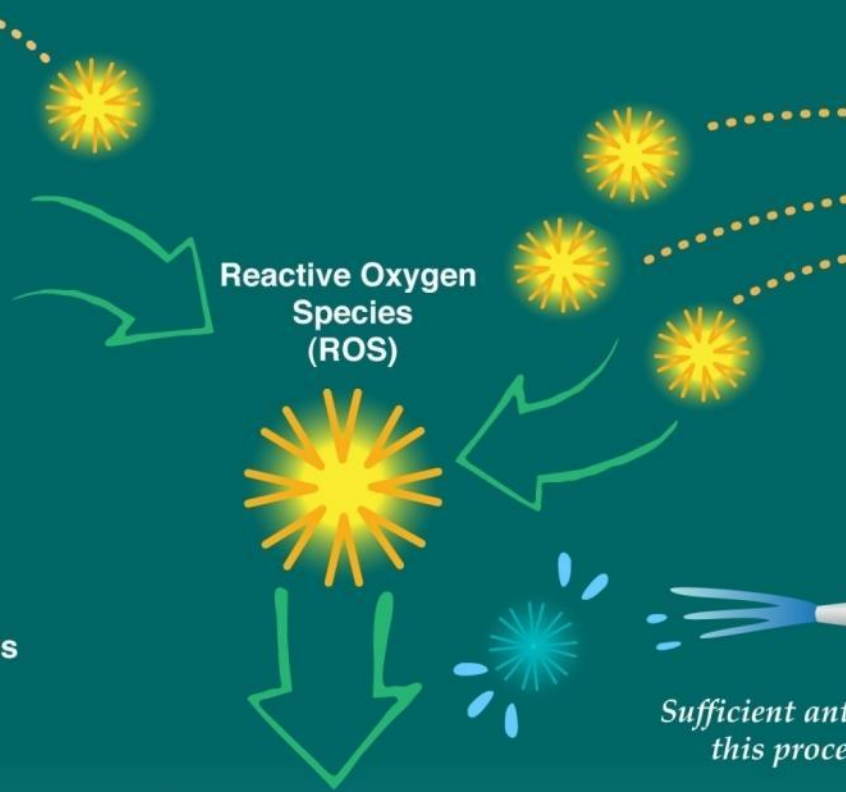
## EXTERNAL

Tobacco smoke  
Industrial pollutants  
Ozone, particulate  
Pesticides  
Radiation  
Anesthetics  
Organic solvents  
Some pharmaceuticals  
High oxygen  
Food\*

ANTIOXIDANTS

*Sufficient antioxidants keep  
this process in check.*

# TISSUE INJURY



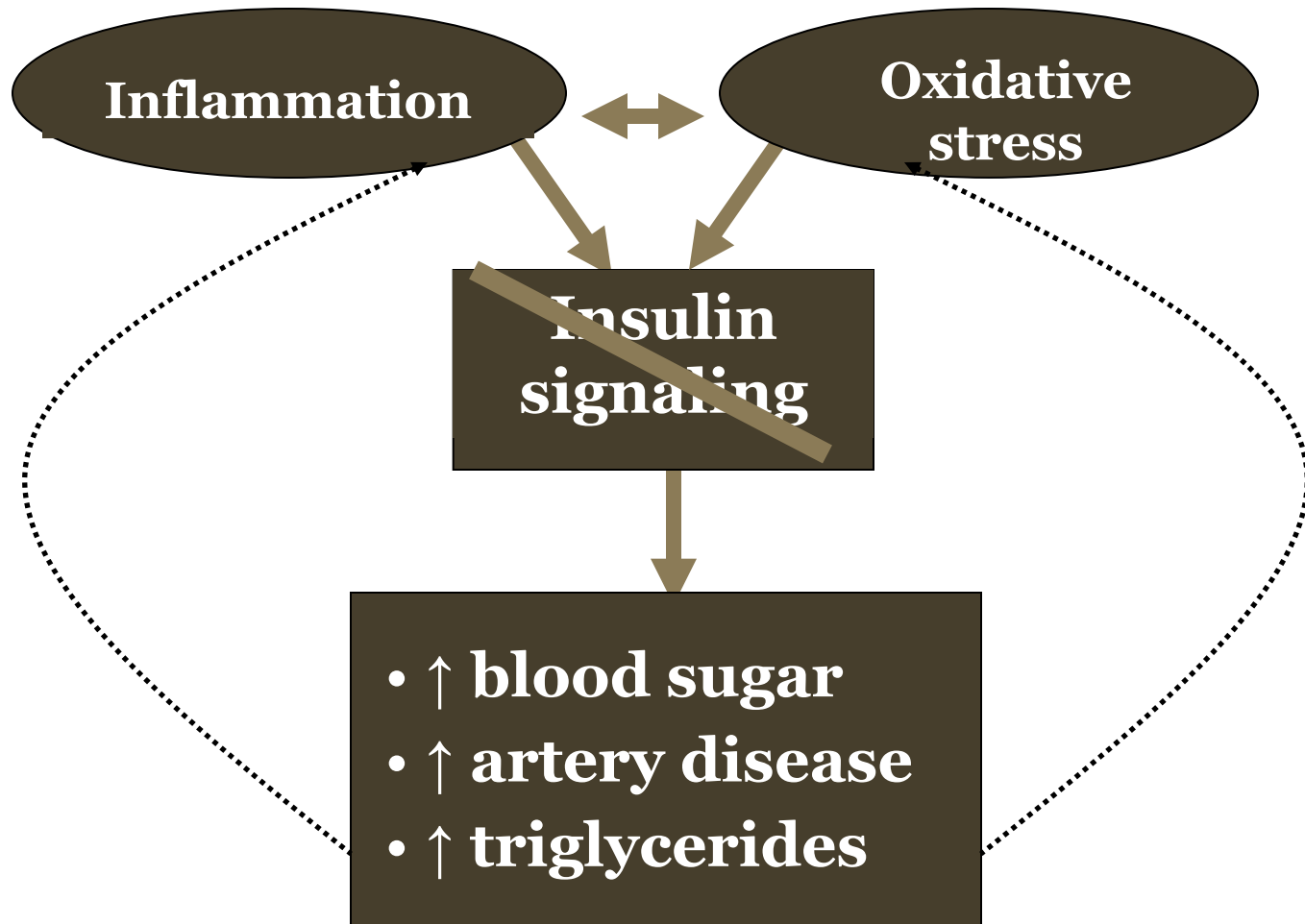
# Insulin Signaling = Normal Metabolism

**Insulin  
signaling**



- **↓ blood sugar**
- **↓ artery disease**
- **↓ triglycerides**

# Disrupted Insulin Signaling = Inflammatory Metabolism



# Some Nutrients Are Increasingly Pervasive and Promote Inflammatory Metabolism

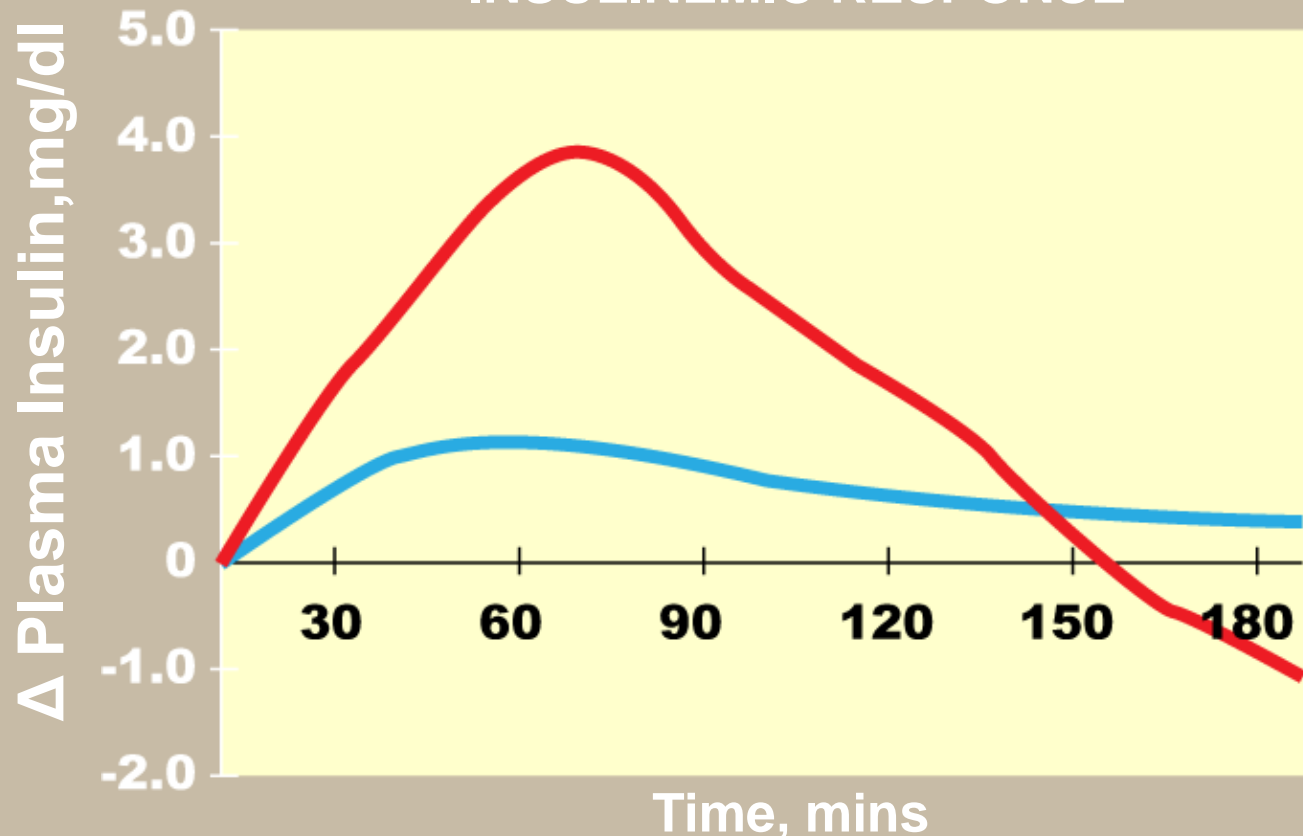


# High Glycemic Carbohydrates Increase the Risk of Chronic Disease



High glycemic carbohydrates break down quickly during digestion, rapidly releasing glucose (sugar) into the bloodstream.

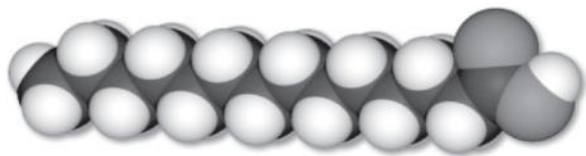
## INSULINEMIC RESPONSE



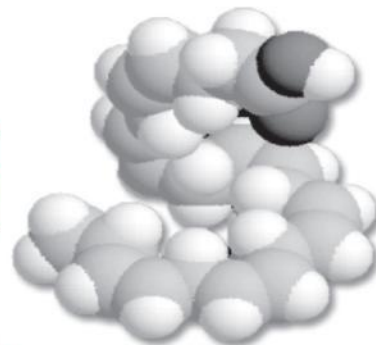
Low glycemic food

High glycemic food

# Types of Fatty Acid



**Saturated fat**



**Unsaturated fat**

**PUFA**

**MUFA**

- Olive oil

**Omega 3**

**Omega 6**

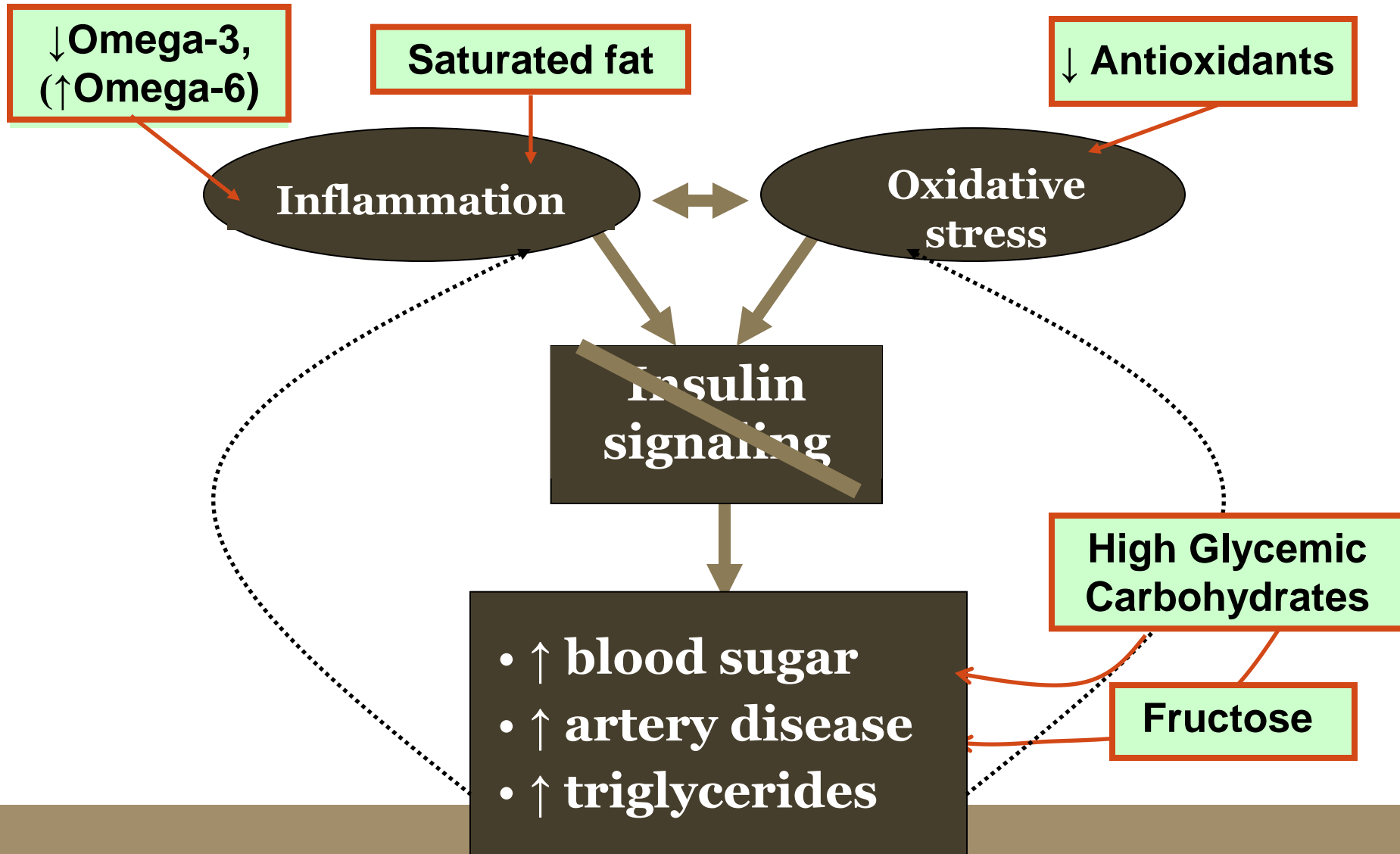
- Fish
- Canola, flax seeds
- Green vegetables
- Products from grazed animals
- Eggs from flax-fed chickens

- Fast & processed food
- Grain-fed animal products
- Corn, soy, sunflower
- Safflower, peanut oils

# Properties of Fatty Acids

|                      | Omega-3  | Omega-6   | Saturated                           |
|----------------------|--|---|-------------------------------------|
| Food System          | <ul style="list-style-type: none"><li>• Perishable</li><li>• Short shelf life</li><li>• Increased in pasture-fed animals</li></ul> | <ul style="list-style-type: none"><li>• Durable</li><li>• Long shelf life</li><li>• Processed foods</li></ul> | Increased in factory-farmed animals |
| Immune Properties    | Anti-inflammatory  | Inflammatory & Anti-inflammatory  | Inflammatory                        |
| Evolutionary Context | Recent marked decline  | Recent marked increase  | Recent marked increase              |

# Nutrient Influences on Insulin Signaling, Inflammatory Metabolism



# Developmental Origins of Adult Disease

“It is suggested that poor nutrition in early life increases susceptibility to the effects of an affluent diet. . .”

Barker DJ, Osmond C. Infant mortality, childhood nutrition, and ischaemic heart disease in England and Wales. *Lancet*. 1986 May 10;1(8489):1077-81.

THE LANCET, MAY 10, 1986

## Epidemiology

### INFANT MORTALITY, CHILDHOOD NUTRITION, AND ISCHAEMIC HEART DISEASE IN ENGLAND AND WALES

D. J. P. BARKER

C. OSMOND

*MRC Environmental Epidemiology Unit, University of Southampton, Southampton General Hospital, Southampton SO9 4XY*

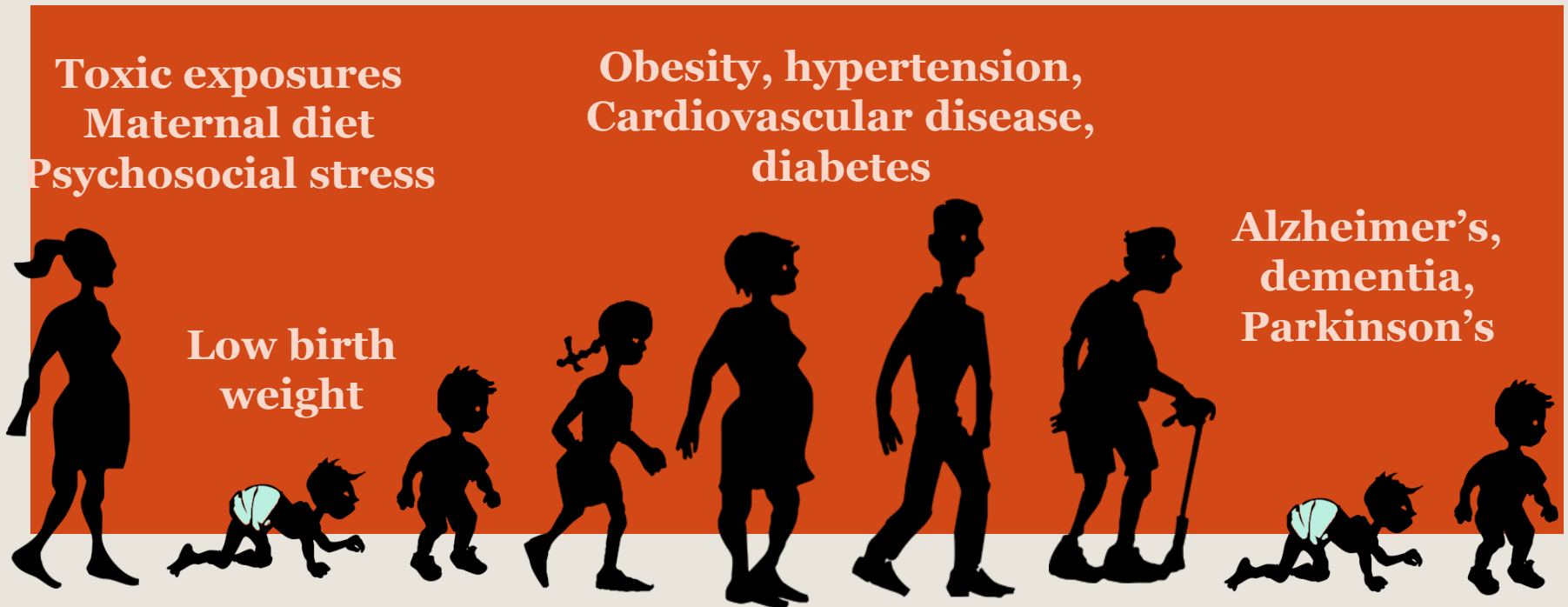
**Summary** Although the rise in ischaemic heart disease in England and Wales has been associated with increasing prosperity, mortality rates are highest in the least affluent areas. On division of the country into two hundred and twelve local authority areas a strong geographical relation was found between ischaemic heart disease mortality rates in 1968-78 and infant mortality in 1921-25. Of the twenty-four other common causes of death only bronchitis, stomach cancer, and rheumatic heart disease were similarly related to infant mortality. These diseases are associated with poor living conditions and mortality from them is declining. Ischaemic heart disease is strongly correlated with both neonatal and postneonatal mortality. It is suggested that poor nutrition in early life increases susceptibility to the effects of an affluent diet.

# The Importance of Early Nutrition: In the Womb & Infancy



- Growth
- Developmental programming
  - Epigenetic: DNA methylation, histone modification, RNA interference
  - Establish “set points” of various phenotypic traits; program immune system, etc.

# Early Life Experiences Can Influence Later-life Health and Disease



**Aging begins at conception**

# Pilot Study: Impact of low glycemic load diet in overweight/obese pregnant women



- n=46
- Low-GL Diet:
  - Longer pregnancy duration (delivery <38 weeks 13% vs. 48%)
  - Greater Infant Head Circumference
  - Lower maternal triglycerides and cholesterol
- Dietary interventions may help prevent premature births and other adverse maternal and infant outcomes
- This study needs to be repeated with larger numbers

# Maternal High Glucose and Increased Risk of Diabetes in Children



- Prenatal exposure to high levels of maternal blood glucose reduces insulin sensitivity in infants
- Gestational diabetes associated with increased risk of Type 2 diabetes in children; not entirely explained by BMI (Dabelea, Diabetes Care, 2008)

# Breast Feeding Advantages: Infant



- Reduced infectious disease
  - pneumonia, gastroenteritis, otitis media, other
- Lower risk of type 1 diabetes; also type 2 diabetes if mother does not have diabetes
- > 6 mo. decreases the risk of childhood cancer
  - leukemia, Hodgkins, neuroblastoma
- Lower risk of inflammatory bowel disease
- Improved neurological development and lower asthma risk (inconsistent evidence)

# Breast Feeding Advantages: Maternal



- Less postpartum bleeding
- Earlier return to pre-pregnancy weight
- Improved bone strength; decreased risk of hip fracture later in life
- Reduced ovarian and pre-menopausal breast cancer
- Birth control
- Women who don't breastfeed have increased risk of type 2 diabetes

# Chronic Disease: Nutrition and Health



- Soda and fast food consumption linked to increased risk of weight gain and diabetes.
- Average consumption of high fructose corn syrup has increased by over 25% in the last 30 years.
- Increase in daily calories over the last 20 years (men 168, women 300).
- High-sugar or high-fat foods comprise almost 30 percent of all calories consumed by Americans.



# Influence of Nutrition on Chronic Disease



- Increase risks
  - saturated and trans fats
  - high glycemic carbohydrates
  - lack of fruits/vegetables/omega 3s
  - excess omega 6s?
- Reduce risks
  - fruits, vegetables, nuts
  - omega 3s
  - low glycemic carbohydrate
  - “Mediterranean-type” diet



# Benefits of Mediterranean-Type Diet on Chronic Disease Risk

## Clinical intervention studies

- 70% ↓ heart attacks, cardiac death & total mortality DeLogeril, 94
- 60% ↓ cardiac events in CVD patients\* Ornish, 98
- ~50% ↓ metabolic syndrome Esposito, 04
- 39% ↓ in CRP Esposito, 04
- ↓ insulin resistance Esposito, 04
- ↓ weight Esposito. 04

\*10% low fat, vegetarian diet + exercise, stress reduction



# Benefits of Mediterranean-Type Diet on Chronic Disease Risk

## Prospective observation studies

- 80% ↓ diabetes Martinez-Gonzalez, 08
- ~31% ↓ all-cause & cardiovascular mortality
- 22% ↓ cancer mortality\*\* calculated from Sofi, 08
- 73% ↓ Alzheimer's mortality Scarmeas, 07
- 25-30% ↓ Parkinson's disease Gao, 07



# Additional Health Concerns Associated with our Industrialized Food System



- **Widespread exposure to toxic chemicals; air pollution; greenhouse gases**
- **Antibiotic resistance**
- **Food-borne illness**
- **Environmental degradation**



# Chemicals in the Food System



## Inadvertent contaminants

- Mercury
- Flame retardants
  - Other

## Intentionally added

- Pesticides
- Bisphenol A
  - Arsenic
  - Antibiotics
  - Other



# Farm Workers and Pesticides



Mark Harrison © The Seattle Times

- **Increased rates of cancer**
- **Increased rates of birth defects and childhood leukemia**
- **Acute pesticide poisoning**

# Pesticides and cancer



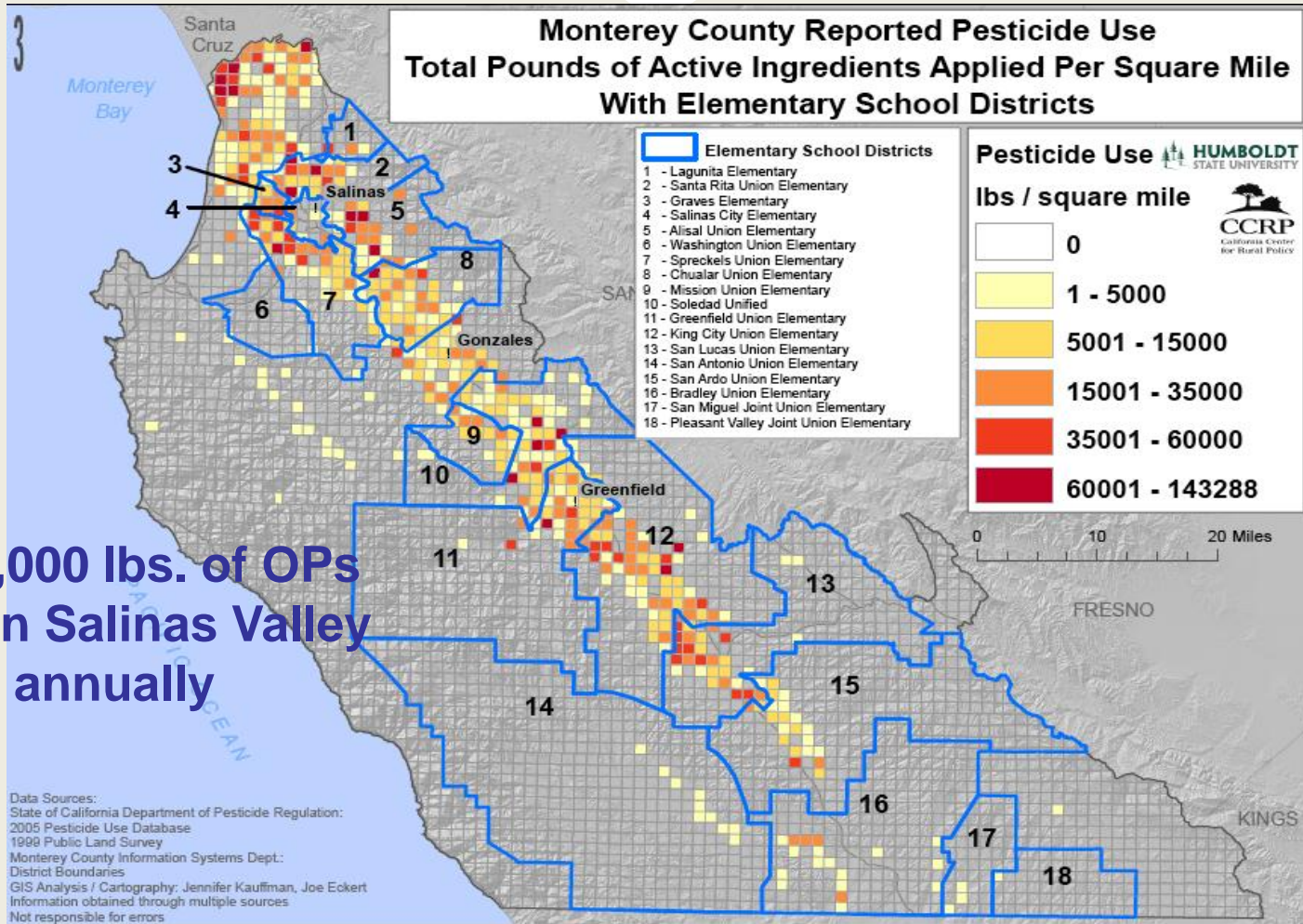
## — Prostate cancer

- Agricultural workers (Agricultural Health Study and others)
- General population (Central Valley CA; OR 2; methyl bromide, organochlorines) . (Cockburn, Am J Epid; 2011)

## — Other cancers associated with pesticides in AHS: lung, colon, pancreas, Non-Hodgkin's lymphoma, leukemia, multiple myeloma, bladder (Weichenthal, EHP, 2010)

## — Breast cancer and DDT; increased risk with higher exposures before age 14 (Cohn, 2007)

# Map of pesticide use in elementary school districts in Monterey County



**>500,000 lbs. of OPs used in Salinas Valley annually**

Data Sources:  
 State of California Department of Pesticide Regulation:  
 2005 Pesticide Use Database  
 1998 Public Land Survey  
 Monterey County Information Systems Dept.:  
 District Boundaries  
 GIS Analysis / Cartography: Jennifer Kauffman, Joe Eckert  
 Information obtained through multiple sources  
 Not responsible for errors

# Organophosphates and neurodevelopment



- Prenatal organophosphate exposures (as measured by metabolites in maternal urine) associated with:
  - Decreased gestation time and poorer neonatal reflexes
  - Decreased Bayley Mental Development Index at 24 mos.
  - Attention deficit at age 5 (stronger at age 5 than age 3 and stronger in boys)  
(Eskenazi, EHP, 2007; Marks EHP, 2010)
  
- Cross-sectional study (NHANES): 8-15 y. o.; higher levels of urinary OP metabolites associated with increased likelihood of ADHD diagnosis (Bouchard, Pediatrics, 2010)

# Pesticides and Parkinson's Disease

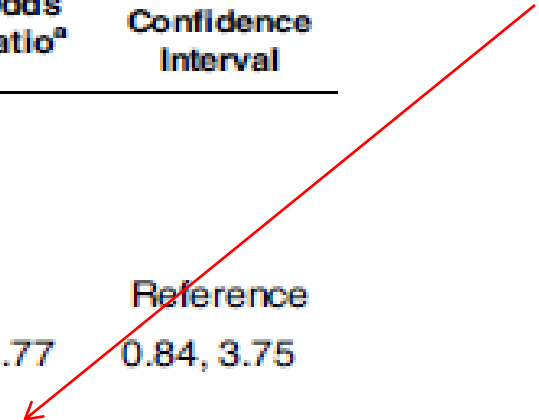


- Human studies –
  - - 24/31 studies show ↑ risks for PD. (OR 1.6-7); positive dose-response where examined (Brown 2006)
  - Animal studies -
    - Combinations of maneb and paraquat; prenatal exposure “primes” the brain, increasing adult susceptibility (Cory-Slechta 2005)
- This combination recently shown to be associated with increased risk in humans as well. (Costello, 2009)

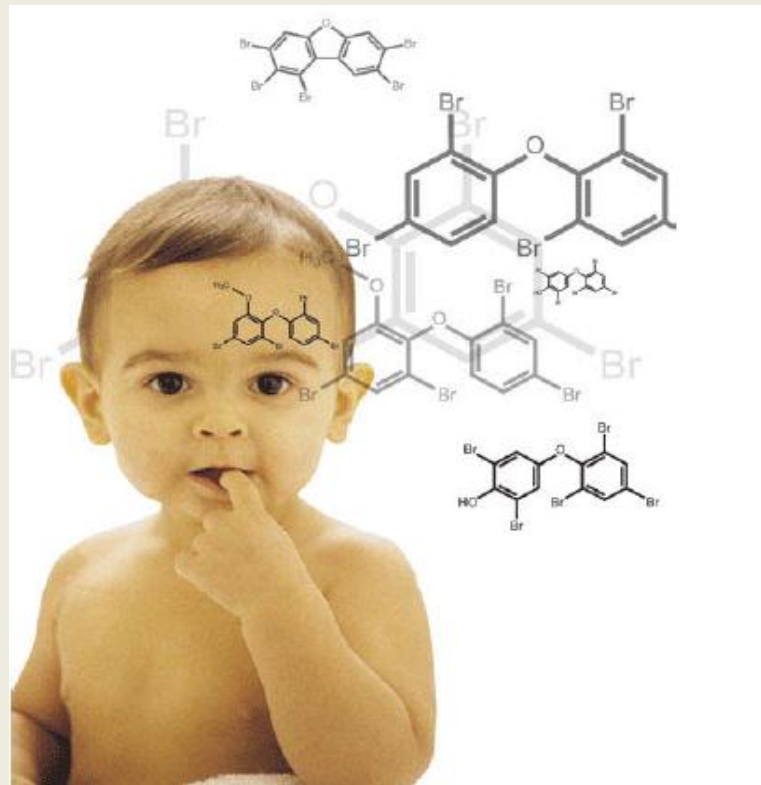
## Case-control; 368 cases; 341 controls

Maneb, paraquat exposures estimated from pesticide use data and GIS land maps; length of residence; controlled for age, smoking, sex, occupational exposures

| Age at time of dx             | Age Group and Exposure       | Cases |    | Controls |    | Odds Ratio <sup>a</sup> | 95% Confidence Interval |
|-------------------------------|------------------------------|-------|----|----------|----|-------------------------|-------------------------|
|                               |                              | No.   | %  | No.      | %  |                         |                         |
|                               | <i>1974–1999 Time Window</i> |       |    |          |    |                         |                         |
|                               | ≤60 years                    |       |    |          |    |                         |                         |
|                               | Missing data                 | 2     | 3  | 4        | 5  |                         |                         |
|                               | No exposure                  | 18    | 23 | 34       | 39 | 1                       | Reference               |
| Exposure within 500 m of home | Paraquat or maneb only       | 38    | 48 | 42       | 48 | 1.77                    | 0.84, 3.75              |
|                               | Both paraquat and maneb      | 21    | 27 | 7        | 8  | 5.07                    | 1.75, 14.71             |
|                               | >60 years                    |       |    |          |    |                         |                         |
|                               | Missing data                 | 11    | 4  | 9        | 4  |                         |                         |
|                               | No exposure                  | 97    | 34 | 92       | 36 | 1                       | Reference               |
|                               | Paraquat or maneb only       | 114   | 39 | 111      | 44 | 0.90                    | 0.60, 1.34              |
|                               | Both paraquat and maneb      | 67    | 23 | 42       | 17 | 1.36                    | 0.83, 2.23              |



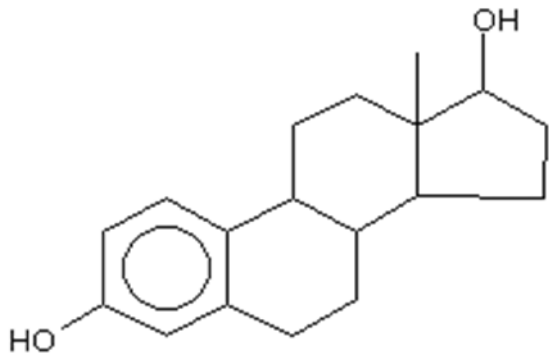
# Emerging Evidence



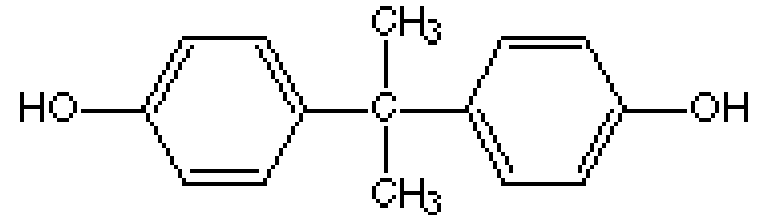
# Bisphenol A (BPA)



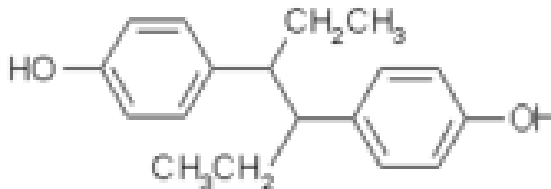
- Over 6 billion pounds produced each year
- Developed as a synthetic estrogen in the 1930s



Estradiol



Bisphenol A



4,4'-(1,2-diethyl-1,2-ethene-diyl)bisphenol  
diethylstilbestrol  
DES

# Bisphenol A (BPA)



## Widespread Human Exposure

- Over 90% of Americans have residues in their urine (CDC)
  - young adults > older adults
  - NHB > Caucasian, Hispanic
- Breast milk, amniotic fluid, cord blood

## Routes of Exposure

- Most is oral, although dermal and inhalation may add
- FDA estimates major exposure is from food
  - Infants > Adults



# BPA Animal Studies



- **Cancer**

- Developmental exposure > prostate intraepithelial neoplasia/cancer
- Altered mammary gland development and predisposes to chemically induced cancer



- **Developmental toxin**

- Altered onset of puberty
- Chromosomal abnormalities

- **Neurodevelopmental toxicant; some evidence in humans (behavioral)**

- **Obesogen/Insulin Resistance (limited human evidence)**

# Systemic Drivers of Diet and Food Choices



- Advertising & Media
- Access & Availability
  - Fast food restaurants, food deserts
- Education, social psychology, and early life experiences
- Cost

# Food Advertising

**\$25-30 billion per year**  
Twice the amount needed  
to provide health and  
nutrition for everyone in  
the world.      -UNDP 1998



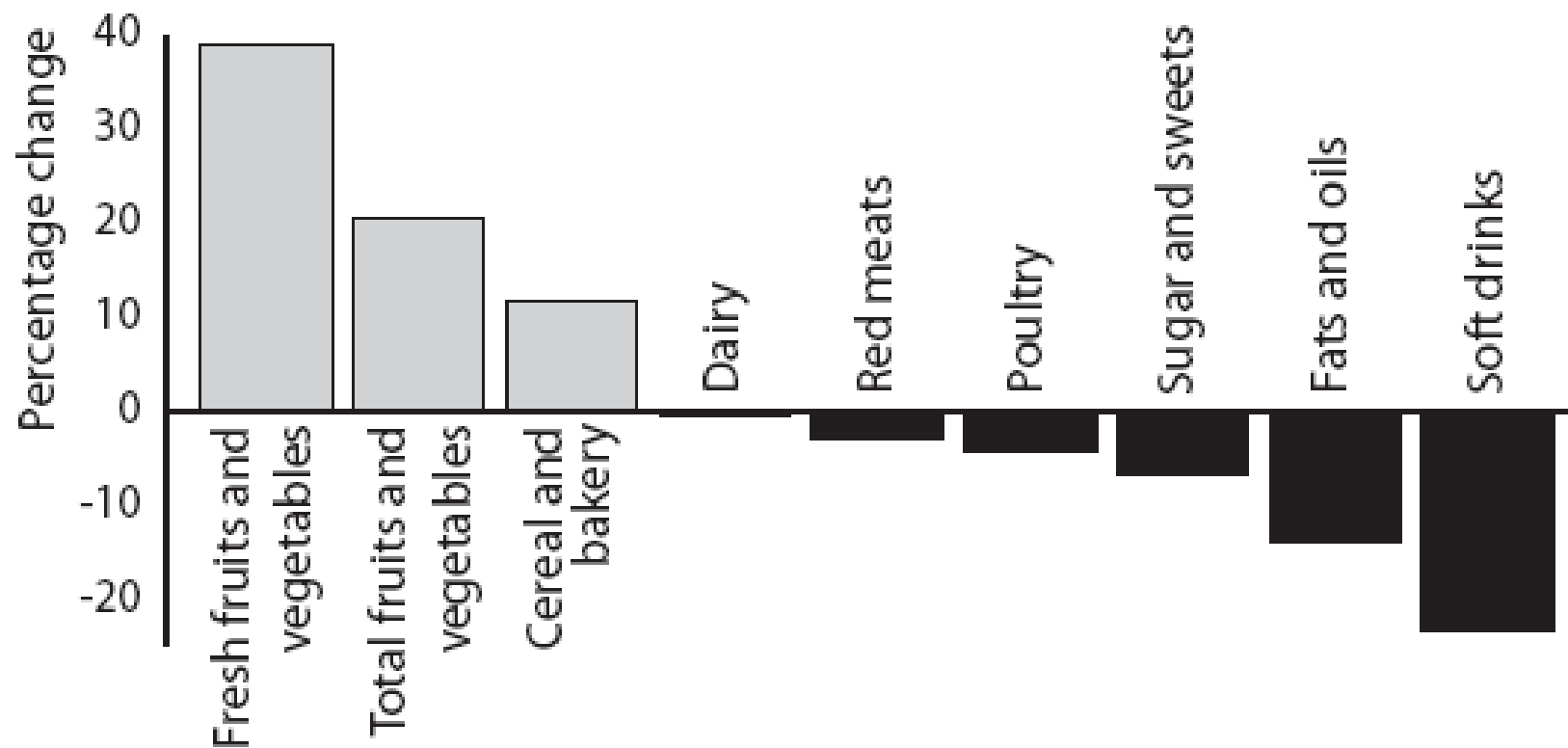
**\$12 billion per year**  
Aimed at marketing to  
children.

# Subsidies: Abundant, low-priced corn and soybeans foster cheap junk foods



# Economic Drivers of Food Choice

Change in food prices, 1985–2000  
(real dollars)



Source: USDA ERS FoodReview, Vol. 25, Issue 3. Converted to real dollars.

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What role can the healthcare sector play in reversing the epidemics of today, and envisioning a healthier future?

