The World is Fat: Global Dynamics, Causes, Policy Options

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Outline: Why is this occurring?

• Global Dynamics: The US is no longer the fattest and rapid shifting in the developing world of the face of obesity
• Causes: Major dietary and eating behavior shifts: global vs high income country differences
• How do we proceed

“Over 1.6 billion people in the world are overweight”
Figure 1. Stages of the Nutrition Transition

Urbanization, economic growth, technological changes for work, leisure, & food processing, mass media growth

Pattern 1
Paleolithic man/Hunter-gathers
- Wild plants & animals
- Water
- Labor intensive

Pattern 2
Settlements begin/Monoculture period/Famine emerges
- Cereals dominate
- Water
- Labor-intensive

Pattern 3
Industrialization/Receding Famine
- Starchy, low variety, low fat, high fiber
- Water
- Labor-intensive work/job/home

Pattern 4
Noncommunicable Disease
- Increased fat, sugar, processed foods
- Caloric beverages
- Shift in technology of work and leisure

Pattern 5
Desired societal/Behavioral Change
- Reduced fat, increased fruit, veg, CHO, fiber
- Increase water, Reduce caloric beverage intake
- Replace sedentarianism w/purposeful activity

Lean & robust, high disease rate
- Low fertility, low life expectancy

Nutritional deficiencies emerge, stature declines
- High fertility, high MCH mortality, low life expectancy

MCH deficiencies, weaning disease, stunting
- Slow mortality decline

Obesity emerges, range of other NR-NCD's
- Accelerated life expectancy, shift to increased DR-NCD, increased disability period

Reduced body fatness, Reduced NR-NCD's
- Extended health aging, reduced DR-NCD

Mismatch: Biology which has evolved over the millennia clashes with modern technology

<table>
<thead>
<tr>
<th>Biology</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet preferences</td>
<td>cheap caloric sweeteners, food processing benefits</td>
</tr>
<tr>
<td>Thirst and hunger/satiety mechanisms not linked</td>
<td>Caloric beverage revolution</td>
</tr>
<tr>
<td>Fatty food preference</td>
<td>Edible oil revolution-high yield oilseeds, cheap removal of oils</td>
</tr>
<tr>
<td>Desire to eliminate exertion</td>
<td>Technology in all phases of movement/exertion</td>
</tr>
</tbody>
</table>

“Over 1.6 billion people in the world are overweight”

BMI Distribution Shifts Among Chinese Adults, ages 19 and Older

China Health and Nutrition Survey. Unpublished, not for distribution
The Shift in BMI levels at the 95th Centile for Females Aged 30

The Shift in BMI Levels at the 95th Centile for Children Aged 6

<table>
<thead>
<tr>
<th>Year</th>
<th>United States</th>
<th>Australia</th>
<th>United Kingdom</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-75</td>
<td>18</td>
<td>21.6</td>
<td>21.6</td>
<td>24.8</td>
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<tr>
<td>1988-94</td>
<td>20.1</td>
<td>20.1</td>
<td>19.8</td>
<td>19.8</td>
</tr>
<tr>
<td>2003-06</td>
<td>18.8</td>
<td>19.8</td>
<td>20.1</td>
<td>19.8</td>
</tr>
</tbody>
</table>

Overweight and Underweight Prevalence in Women 20-49y in 36 Developing Countries Ranked by Gross National Income (GNI) Per Capita

(1a) Urban Women

(1b) Rural Women

Overweight = BMI ≥25; underweight = BMI <18.5.

Mendez, Monteiro, Popkin (2005): AJCN
Weighted prevalence of Overweight Plus Obesity among Women in Developing Countries

Rural Women

- East & Southern Africa
  - 43 countries: 18.6, 16.5
- West Africa
  - 13.6
- Central Africa
  - 11.7
- Middle East & North Africa
  - 15.0
- Asia
  - 5.9
- Latin America
  - 6.9

Urban Women

- East & Southern Africa
  - 43 countries: 26.0
- West Africa
  - 32.4
- Central Africa
  - 33.5
- Middle East & North Africa
  - 34.5
- Asia
  - 59.8
- Latin America
  - 56.2

Ng, Jones-Smith and Popkin, unpublished not for use or quotation
Annual Change in Weighted Prevalence of Overweight plus Obesity (BMI ≥25) among Women in Developing Countries

<table>
<thead>
<tr>
<th>Region</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Latin America</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Asia</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Middle East &amp; North Africa</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Central Africa</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>West Africa</td>
<td>0.8</td>
<td>1.3</td>
</tr>
<tr>
<td>East &amp; Southern Africa</td>
<td>0.6</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Relative annual change in OWOB (%):

<table>
<thead>
<tr>
<th>Region</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia</td>
<td>-0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Latin America</td>
<td>4.6</td>
<td>5.1</td>
</tr>
<tr>
<td>Asia</td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Middle East &amp; North Africa</td>
<td>2.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Central Africa</td>
<td>5.1</td>
<td>5.7</td>
</tr>
<tr>
<td>West Africa</td>
<td>3.4</td>
<td>3.2</td>
</tr>
<tr>
<td>East &amp; Southern Africa</td>
<td>4.0</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Ng, Jones-Smith and Popkin, unpublished not for use or quotation
Trends in Overweight plus Obesity Prevalence: Latin America & Caribbean

Overweight and Obese for Adults Aged 18 and Older
UK, USA, Australia, and Russia
(high income countries)
Old: Patterns Of Overweight & Obesity Globally For Nationally Representative Samples
(Percentage overweight + Obese)

Australian Youth Gain Fat, Shift Body Shape


“Over 1.6 billion people in the world are overweight”
The consequences vary by race-ethnicity: Body fat composition in the East vs the West

“Over 1.6 billion people in the world are overweight”

What drives caloric increases and leads to added energy imbalance?

- The only possible consensus is that caloric beverages are linked with increased total energy intake and weight gain
- We know that total weight gain or loss can occur with any diet: high/low protein, fat, or complex carbohydrates diets work
- But what is driving dietary change and keeping calories higher: that is much clearer

“Over 1.6 billion people in the world are overweight”
Sources of Major Global Dietary Shifts

- Globally: large increases in consumption of *caloric beverages* and increasing number of *eating occasions*. Unclear trends in kcal/day
- Globally: we find an increased intake of *ultra processed foods*, *refined carbohydrates*
- Globally: we find a reduced intake of *legumes* and in most countries a reduction of *vegetable* intake but in some cases increased fruit intake.
- Globally: we find a reduced preparation time, increased use of precooked foods
- Lower income countries: increased *edible oil*, *animal source foods* are another source of kcal increase

“Over 1.6 billion people in the world are overweight”

From Traditional to Modern Snacking
Role of our history

- Core biochemical and physiologic processes have been preserved from those who appeared in Africa between 100,000 and 50,000 y ago. Genetic evolution during subsequent millennia has continued, as shown by pigmentation changes (hair, eyes, skin), intestinal lactase retention beyond infancy, and adaptive defenses against microorganisms (e.g., hemoglobinopathies and immune system adaptations).

“Over 1.6 billion people in the world are overweight”

Sweetness Preference

Many think that we have inborn biological wisdom but how and why and what role this plays in our food preferences has not achieved consensus. Because sweet foods are naturally good and are safe sources of energy and nutrients, many believe adaptive evolutionary development has resulted in a preference for them. These early responses are modified by life experiences, producing our tastes and preferences.

What about conditioning, issues of habituation: animal models do not help. We know little.

“Over 1.6 billion people in the world are overweight”
Sweetness Preference was Essential to Survive: Huge Shift in Amounts, Energy Density

“Over 1.6 billion people in the world are overweight”

What are the implications of eating food and drinking water on energy balance?

<table>
<thead>
<tr>
<th>General Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food</strong></td>
</tr>
<tr>
<td><strong>Hunger – Feeding</strong></td>
</tr>
<tr>
<td>Sensations that promote attainment of minimal food energy needs</td>
</tr>
<tr>
<td><strong>Energy Excess</strong></td>
</tr>
<tr>
<td>Stored</td>
</tr>
<tr>
<td><strong>Energy Deficit:</strong> Die in 1-2 months</td>
</tr>
</tbody>
</table>

“Over 1.6 billion people in the world are overweight”
Increases in total calories from added sugar are greatest among top 20% of population

<table>
<thead>
<tr>
<th>Year</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>60</td>
<td>161</td>
<td>262</td>
<td>396</td>
<td>701</td>
<td>316</td>
</tr>
<tr>
<td>1977</td>
<td>32</td>
<td>114</td>
<td>195</td>
<td>299</td>
<td>560</td>
<td>240</td>
</tr>
<tr>
<td>1989-91</td>
<td>29</td>
<td>113</td>
<td>206</td>
<td>324</td>
<td>616</td>
<td>258</td>
</tr>
<tr>
<td>1999-00</td>
<td>62</td>
<td>193</td>
<td>321</td>
<td>491</td>
<td>959</td>
<td>406</td>
</tr>
<tr>
<td>2001-02</td>
<td>59</td>
<td>176</td>
<td>300</td>
<td>464</td>
<td>882</td>
<td>376</td>
</tr>
<tr>
<td>2003-04</td>
<td>56</td>
<td>172</td>
<td>295</td>
<td>646</td>
<td>896</td>
<td>377</td>
</tr>
</tbody>
</table>

-8.3%  

Duffey & Popkin (2008)  AJCN 88(suppl):1722S

“Over 1.6 billion people in the world are overweight”

Steepest increase in calories of added sugar from soda, per capita and consumer estimates

Duffey & Popkin (2008)  AJCN 88(suppl):1722S
Association Between Beverage Consumption and Positive Energy Balance

- Consistent—except few industry funded studies
- Strong—very important dose-response relationship
- Biologically very important: large shifts intake, large shifts caloric intake found in animal, clinical, observational, RCT. Have few large RCT’s.

“Over 1.6 billion people in the world are overweight”

Comparison of consumption of a beverage and a solid food on total Energy Intake shows beverage consumption in any macronutrient form significantly increases dairy energy intake

![Comparison of consumption of a beverage and a solid food on total Energy Intake](image)

Remarkably Short History for Caloric Beverages: Might the Absence of Compensation Relate to This Historical Evolution?

Global Trends

- Minimal published data
- Mexico-see below.
- Working on UK, Spain, China, children across Europe,

“Over 1.6 billion people in the world are overweight”
Daily Beverage Consumption Trends Among Mexican Children, 1999-2006

Note: Sweetened juice drinks include 100% fruit juice with sugar added and agua fresca (water, juice, sugar). Sodas include carbonated and noncarbonated sugar bottled beverages.

Beverage consumption trends among Mexican adolescents and adult women, 1999 and 2006

Note: High sugar is composed of mainly soft drinks, sweetened juices, agua frescas and alcohol. High calorie and low benefit is mainly whole milk. Low calories are slightly sweetened coffee and skim milk.
UK Beverage Group Trends
(Grams purchased per person per week)

Per Capita Change in Calories from Beverages
Between 1965 and 2002 among US adults (≥19)
Long Steady Decline of Total Milk Intake

- Total Whole Milk, Plain & Flavored
- Total Lower Fat & skim Milk
- Total All Milk


Juices

- Several studies from Australia, the US and Spain show a comparable effect of juices on energy intake, weight gain and CVD

“Over 1.6 billion people in the world are overweight”
Juice Consumption Trends (Kcal/Day), Nationally Representative


Alcohol

- The increase in alcohol intake is often overlooked

“Over 1.6 billion people in the world are overweight”
Alcohol Consumption Trends (kcal/day), Nationally Representative


So what about noncaloric beverages?

- Sweetened diet beverages: Complex. Our work in process suggests it is the diet linked with these beverages that determines the effect and not the diet beverages (see Mattes and Popkin, AJCN (2009) 84:)
- Diet sweeteners and health: two pictures. Healthy diet with diet sweeteners and those who use diet sweeteners to consume unhealthy foods.

"Over 1.6 billion people in the world are overweight"
"Over 1.6 billion people in the world are overweight"

"I use artificial sweeteners, so what you’re really seeing is artificial fat."

Trends in Consumption of Diet Beverages among Americans (≥ 2 Years)

<table>
<thead>
<tr>
<th>Year</th>
<th>Grams per capita</th>
<th>% of pop. Consuming</th>
<th>Grams per consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>10</td>
<td>2.5</td>
<td>368</td>
</tr>
<tr>
<td>1977</td>
<td>22</td>
<td>4.8</td>
<td>417</td>
</tr>
<tr>
<td>1989-91</td>
<td>71</td>
<td>10.1</td>
<td>546</td>
</tr>
<tr>
<td>1999-2000</td>
<td>109</td>
<td>9.1</td>
<td>736</td>
</tr>
<tr>
<td>2001-2002</td>
<td>108</td>
<td>9.4</td>
<td>711</td>
</tr>
<tr>
<td>2003-2004</td>
<td>129</td>
<td>10.8</td>
<td>752</td>
</tr>
</tbody>
</table>


"Over 1.6 billion people in the world are overweight"
Water

- Water consumption measurement is fairly crude with minimal effort on this critical nutrient
- Water research: very limited. Some studies beginning to suggest important direct calorie replacement and possibly added effects of water on energy intake, weight and metabolic functioning

“Over 1.6 billion people in the world are overweight”

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**Difference in Total Energy Intake when Juice or Milk Displace Water**

<table>
<thead>
<tr>
<th>Study</th>
<th>Change (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almiron Roig (2003) adults</td>
<td>19.7†</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>DellaValle (2005) women</td>
<td>10.9†</td>
<td></td>
</tr>
<tr>
<td>Almiron Roig (2003) men</td>
<td>15.5†</td>
<td></td>
</tr>
<tr>
<td>Almiron Roig (2003) women</td>
<td>12.1</td>
<td></td>
</tr>
<tr>
<td>DellaValle (2005) women</td>
<td>15.1†</td>
<td></td>
</tr>
<tr>
<td>Hagg (1998) kids 4-7</td>
<td>16.7†</td>
<td></td>
</tr>
<tr>
<td><strong>Weighted Average (Juice &amp; Milk)</strong></td>
<td>14.9</td>
<td></td>
</tr>
</tbody>
</table>

*P<0.05
Popkin, et al, under review; Daniels and Popkin, under review;
Differences in Total Energy Intake
When Diet Beverages Displace Water
(6 kids; 19 adult comparisons; sig shown)

-11.4†
-9.1†
-13.8†
-6.7
-1.3

Water and Health

- 4 epidemiological studies suggest replacing SSB’s with water might reduce kcals by about ≥200 kcals
- German controlled trial found that replacing vending machines and choices of any beverage with filtered water fountains plus water education reduced risk of overweight by 31%
- Absence of good random controlled trials

"Over 1.6 billion people in the world are overweight"
Total Caloric Intake is a Combination of Three Components

- Total caloric intake = f(Meal Size x Eating Frequency x energy density of the meal)
- Meal sizes ↑: US, UK, Germany, other countries
- Eating Frequency ↑↑: large increase documented in few countries, seeing new global increases. Snacks are significantly greater energy density
- Energy density ↑↓: biggest shift toward higher Number & size snacks of higher energy density; caloric beverages increased also in tot. volume

“Over 1.6 billion people in the world are overweight”

Snacking

- Increased numbers of snacking events over the last 40 years, particularly the past 8 years
- Shift in types of food consumed

“Over 1.6 billion people in the world are overweight”
Number of Snacks per Day Have Gone Up Significantly Among US children aged 2-18

Ages 2-6 ■ Ages 7-12 ■ Ages 13-18 ■ Ages 2-18

Note: if a person ate a meal and some snack food with it, it was classified as a meal.
Source: Pinelas and Popkin, Health Affairs, in press.

The Proportion of Snacking Calories in U.S. Children Aged 2-18 Years Old

Sweetened Beverages
2003-06 14.5% 1977-78 14%
8.4 % 0.1 % 9.8 % 0.2 %
Regular soft drinks Chalk soft drinks Fruit drinks Sport drinks

Juice & Fruit
2003-06 9.4% 1977-78 10.4%
4 % 5.4 % 2.1 % 8.3 %
Fruit juice Fresh fruit

Milk & Dairy
2003-06 8.4% 1977-78 12.8%
6.3 % 1.0 % 11.9 % 0.4 %
High fat milk Low fat milk High fat dairy Low fat dairy

Desserts
2003-06 21.4% 1977-78 26.7%
17.6 % 3.8 % 26.7 % 3.0%
High fat desserts Low fat desserts

Salty Snacks
2003-06 15.7% 1977-78 8.1%
7.3 % 1.6 % 7.3 % 0.8%
High fat salty snacks Low fat salty snacks

Other Snacks
2003-06 11.8% 1977-78 9.9%
8.5 % 1.7 % 6.7 % 2.5%
Candies Nuts and seeds Ready-to-eat cereals

Percentage of energy from snacking
0 5 10 15 20 25 30
Does the physiological basis for eating exist any more? Continuous caloric intake is becoming the norm.

“Over 1.6 billion people in the world are overweight”

Percentiles of US Individuals Consuming Meals Plus Snacks

How We Move

• Shifts in the composition of occupations and the activity within each occupation
• Shifts in production at home: new assets, reduced time in all activities
• Shifts in the ways we travel
• Shifts in leisure

“Over 1.6 billion people in the world are overweight”

From Traditional to Modern Household Production
From Traditional to Modern Economic Work at Home

From Traditional to Modern Leisure
From Traditional to Modern..... Transportation

How do we proceed?

- Clearly action needed at all levels; however I believe the only way to produce concerted change is to look to the models of tobacco use, seat belt, other major public health changes
- Regulations, taxation, mass education are key components
- Examples: UK Foresight Commission, Mexico Beverage campaign, US Farm Bill, Brazil and Singapore schools

“Over 1.6 billion people in the world are overweight”
Economic Policies Might Work

- Examples show the potential.
- However no examples exist for unhealthy foods taxed for healthy reasons with any linkage to diet or other measures of health.
- Tobacco is the prime example

“Over 1.6 billion people in the world are overweight”

Mexico’s Initiative on Beverages

- In government programmes, Mexico has stopped using whole milk, uses only 1.5%-fat milk and will shift fully to skim milk
- In schools, sugar-sweetened beverages are banned, safe drinking water is provided and the sale of water and low-fat milk is allowed
- Mexico is considering taxing added sugars in beverages per gram and fat in milk

“Over 1.6 billion people in the world are overweight”
Limitations to Current Studies of Food Price Shifts on Dietary Intake in the US

- No studies examine the effects of food prices on individual dietary intake in the US except broad ecological relationships done in a cross-sectional manner.
- Creation for CARDIA cohort of adults followed over 20 years with clinical exams, fasting blood, detailed dietary data.
- UNC team linked food price data longitudinally with each community.
- Focus on prices of beverages and fast foods here (Duffey et al, Archives of Internal Medicine, 2010)

“Over 1.6 billion people in the world are overweight”
**Methods: Price Elasticity of Demand**

- Elasticity = % change in demand / % change in price

- Own-price elasticity

  ![Image](coca-cola-soda.png)

- Cross-price elasticity

  ![Image](coca-cola-soda.png)

“Over 1.6 billion people in the world are overweight”

US example: similar ones from Mexico and the UK now. Adult health significant improvement with a 10% change in the price of soda

```
Percent Change in outcome

Total Energy: -1.1
Body Weight: -0.3
HOMA-IR: -1.9
```

Source: Duffey et al, Archives of Internal Medicine, 2010

“Over 1.6 billion people in the world are overweight”
Consequences of China’s Accession to WTO

- China eliminated a quota and replaced it with a 10% tariff
- The production of edible oil began to compete with imports, the number of factories fell by half and a transition to modern huge factories in ongoing.
- Imports are still very important and expected to rise
- The decline in prices of edible oils will accelerate with imports
- These changes portend large increases in oil intake

"Over 1.6 billion people in the world are overweight"
**The Global Food Industry**

- The global food industry is **NOT** as omnipresent as believed. In almost all countries, at least 50-60% of all processed foods are locally produced.
- **The good**: Global producers have great technology, are subject to global pressures, have the technology to make changes and have the means to do so. But, there have not yet been major reductions of kcal.
- **The bad**: Without government regulations, truly meaningful agreements are not possible.
- **The ugly**: The multitude of local unfettered manufacturers or small regional distributors

“Over 1.6 billion people in the world are overweight”
Label on the Front of the Package

- There are a number of initiatives across the globe
- UK: traffic likes Generally good but some confusion
- Mexico: Choices International type of front logo-- being worked out under scientific and government leadership
- Europe, Israel, India, other countries: Choices International

“Over 1.6 billion people in the world are overweight”

Need For Alignment

- Proliferation of labels
  - Numerous front-of-pack symbols and icons
- Little uniformity
  - Derived from different criteria, have various meanings
- Concerns about potential confusion
  - Clutter the aisles and shoppers’ minds

“Over 1.6 billion people in the world are overweight”
Nutrition Criteria by Category

• **Nutrients that should be limited**: Total fat, saturated fat, trans-fat, added sugars and added sodium

• **Nutrients that should be promoted**: Whole grains (Europe, Mexico)

• **Food groups to promote**: Fruits, vegetables, whole grains, legumes, fat-free/low-fat dairy
Mexico Front of the Package Labeling

- Government plus scholars are working to create standards, goals, cutoffs (reduce added sugar and salt and sat fat, increase whole grains, fruits and veggies)
- Industry meeting to work to review draft standards and discuss feasibility. Wal-Mart, Kraft, Unilever, Bimbo, Kellogg’s, Coca Cola, local Pepsi all will support and meet to comment in small meeting

“Over 1.6 billion people in the world are overweight”

Summary

- Concern of major increases in potentially obesogenic eating behaviors
- Concern shift to even higher BMI’s among upper centile levels
- Food policy. Many unanswered issues. Limited evidence of the effectiveness on food choice of taxation or price manipulation as it affects energy balance. Lot on shifting purchases but not the same
- Food industry: focus typically is on the global multinationals. Need more research on others

“Over 1.6 billion people in the world are overweight”
“The most serious epidemic ever is insidiously engulfing the world. Barry Popkin draws upon his decades of research and experience to describe its origins—and a set of potential solutions. Those interested in the future of mankind should read this book.”

Walter Willett, author of *Eat, Drink, and Be Healthy*, and chair, *Department of Nutrition, Harvard University*