Global Burden of Disease Attributable to Sugar Sweetened Beverages

Dariush Mozaffarian, MD DrPH
Dean, Friedman School of Nutrition Science & Policy

Press Conference
Mexico City, Mexico
November 11, 2014
The State of U.S. Health, 2010

Risk Factors
- Dietary risks
- Tobacco smoking
- High blood pressure
- High body mass index
- Physical inactivity and low physical activity
- High fasting plasma glucose
- High total cholesterol
- Ambient particulate matter pollution
- Alcohol use
- Drug use
- Lead exposure
- Occupational risks
- Low bone mineral density
- Residential radon
- Ambient ozone pollution
- Intimate partner violence
- Childhood sexual abuse

US Burden of Disease Collaborators, JAMA 2013
The top global risk factors for mortality in 2010

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Global</th>
<th>High-income Asia Pacific</th>
<th>Western Europe</th>
<th>Australia</th>
<th>High-income North America</th>
<th>Central Europe</th>
<th>Latin America</th>
<th>East Asia</th>
<th>Tropical, Latin America</th>
<th>Latin America and the Caribbean</th>
<th>South Asia</th>
<th>Sub-Saharan Africa</th>
<th>Sub-Saharan Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High blood pressure</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Smoking</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Household air pollution</td>
<td>4</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>18</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Alcohol use</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>High body-mass index</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>High fasting plasma glucose</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Childhood underweight</td>
<td>8</td>
<td>21</td>
<td>20</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Ambient PM pollution</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>16</td>
<td>10</td>
<td>9</td>
<td>14</td>
<td>9</td>
<td>4</td>
<td>16</td>
<td>10</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Physical inactivity</td>
<td>10</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Occupational risks</td>
<td>11</td>
<td>10</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Iron deficiency</td>
<td>12</td>
<td>14</td>
<td>17</td>
<td>13</td>
<td>18</td>
<td>14</td>
<td>12</td>
<td>13</td>
<td>11</td>
<td>10</td>
<td>13</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Suboptimal breastfeeding</td>
<td>13</td>
<td>25</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>16</td>
<td>15</td>
<td>12</td>
<td>13</td>
<td>12</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>High total cholesterol</td>
<td>14</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>9</td>
<td>10</td>
<td>13</td>
<td>14</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>Drug use</td>
<td>15</td>
<td>11</td>
<td>11</td>
<td>13</td>
<td>9</td>
<td>13</td>
<td>10</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>12</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Intimate partner violence</td>
<td>16</td>
<td>12</td>
<td>14</td>
<td>13</td>
<td>16</td>
<td>13</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>17</td>
<td>16</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Lead</td>
<td>17</td>
<td>15</td>
<td>13</td>
<td>11</td>
<td>14</td>
<td>12</td>
<td>14</td>
<td>15</td>
<td>12</td>
<td>16</td>
<td>17</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Sanitation</td>
<td>18</td>
<td>20</td>
<td>21</td>
<td>21</td>
<td>23</td>
<td>24</td>
<td>22</td>
<td>23</td>
<td>22</td>
<td>21</td>
<td>23</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Vitamin A deficiency</td>
<td>19</td>
<td>22</td>
<td>22</td>
<td>20</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>23</td>
<td>22</td>
<td>20</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Zinc deficiency</td>
<td>20</td>
<td>19</td>
<td>19</td>
<td>17</td>
<td>19</td>
<td>21</td>
<td>21</td>
<td>22</td>
<td>21</td>
<td>22</td>
<td>21</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Childhood sexual abuse</td>
<td>21</td>
<td>16</td>
<td>15</td>
<td>12</td>
<td>12</td>
<td>18</td>
<td>15</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>19</td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td>Unimproved water</td>
<td>22</td>
<td>23</td>
<td>23</td>
<td>22</td>
<td>20</td>
<td>22</td>
<td>24</td>
<td>23</td>
<td>21</td>
<td>22</td>
<td>19</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>Low bone mineral density</td>
<td>23</td>
<td>23</td>
<td>12</td>
<td>15</td>
<td>15</td>
<td>17</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>20</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Ozone</td>
<td>24</td>
<td>18</td>
<td>18</td>
<td>23</td>
<td>17</td>
<td>19</td>
<td>25</td>
<td>20</td>
<td>25</td>
<td>20</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Radon</td>
<td>25</td>
<td>17</td>
<td>16</td>
<td>18</td>
<td>16</td>
<td>17</td>
<td>20</td>
<td>18</td>
<td>20</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
</tbody>
</table>

http://www.healthmetricsandevaluation.org/gbd/visualizations/gbd-heatmap
Diet & Obesity/Diabetes: Conventional Wisdom

"Calories In, Calories Out"

Energy In (Intake)

Energy Out (Expenditure)

Adiposity

Total Fat Energy Density

Type 2 Diabetes Mellitus
Advances in Nutritional Science

Randomized Trials of Disease Outcomes

Prospective Cohorts of Disease Outcomes

Randomized Trials of Physiologic Measures / Risk Factors

Retrospective Case-Control Studies of Disease Outcomes

Animal Studies

Ecologic Studies

Prevalence Studies

Harris, Mozaffarian et al., J Nutrition 2009
Diet & Obesity/Diabetes: Modern Science

Energy Out (Expenditure)

Energy In (Intake)

Adiposity

Type 2 Diabetes Mellitus

Foods / Diet Quality:
Carbohydrate Quality
Nuts, Fruits, Vegetables, Dairy, Meats
Fats and Oils
Dietary Patterns

Mozaffarian et al., NEJM 2011
Ebbeling et al., JAMA 2012
Complex influences of different foods on:

- Hunger, fullness
- Insulin, adrenalin, other hormonal responses
- Liver fat production (de novo lipogenesis, conversion of carbohydrate to fat)
- Brain reward
- Microbiome
- Metabolic expenditure (energy out)

e.g., Browning AJCN 2011; Ebbeling JAMA 2012; Poutahidis Plos ONE 2013; Lennerz AJCN 2013; Ludwig JAMA 2014
Preventing Chronic Diseases: Food Patterns
Dietary Priorities for Good Health

EAT:
• Fruits
• Nuts and Seeds
• Fish and Seafood
• Vegetables
• Vegetable Oils
• Whole Grains
• Moderate Dairy

LIMIT:
• Refined Grains, Starches, Sugars
• Processed Meats
• Sweetened Drinks
• Industrial Trans Fat
• Salt
• Alcohol

Mozaffarian, Appel, and Van Horn. Circulation 2011
Among 120,877 men and women followed for 20 years, adjusted every 4 years for age, baseline BMI, sleep, and changes in activity, smoking, TV watching, and all dietary factors simultaneously.

Mozaffarian et al., NEJM 2011
SSBs and Incident Diabetes

Risk for 1+ drink (12 oz) per day, compared with <1 per month

Among 91,249 women followed for 8 years. Schulze et al., JAMA 2004
Impact of SSBs on Global Health?
Compiled Global Data on SSB Consumption

- 63 individual-level dietary surveys, 1980-2010
  - 54 countries
  - 720,859 individuals
  - 88% nationally representative
  - Covering 63% of the world’s population

- United Nations FAO food balance sheets, 1980-2010
  - National availability of sugar
  - 187 countries
  - Covering 99.9% of the world’s population
• Evaluated sugar-sweetened soda, energy drinks, sweet iced tea, frescas.

• Excluded diet soda, 100% fruit juice.
Global Deaths Attributable to SSBs in 2010

- In 2010, **184,000** (95% CI: 161,000-208,000) deaths/year were attributable to SSBs worldwide. Globally, this represents **1.2%** of all of diabetes, CVD, and obesity-related deaths.

- **72%** from diabetes, **24%** from CVD, and **4%** from cancers.

- Numbers of SSB-related deaths similar in **men vs. women**.

- In **Mexico**, SSBs cause **24,100 deaths/year**. This is **1 in 8 (12.1%)** of all diabetes, CVD, and obesity-related cancer deaths in Mexico. Among younger women and men (<**age 45**), SSBs cause **22%** and **33%** of all diabetes, CVD, and obesity-related deaths.

- **Not only a rich-country problem**: More overall SSB-related deaths in low/middle-income countries than in high-income countries.

Singh et al., *submitted*
Barriers and Opportunities for Healthy Eating

Afshin, Mozaffarian et al, The Handbook for Global Health Policy
Healthy Diet Policies: Barriers

• Incomplete policy maker knowledge on key dietary targets:
  – *Not* just “calories”.

• Insufficient use of the best evidence-based policies:
  – Considerable emphasis on labeling, information, education, guidelines.
  – Very little focus on other complementary approaches.

• Opposition, by food industry, hunger groups, the public.

• “Disease-treatment” health care system:
  – Diversion of both attention and resources.
Lessons From Past Public Health Successes

FIGURE 1. Motor-vehicle–related deaths per million vehicle miles traveled (VMT) and annual VMT, by year — United States, 1925–1997

US Centers for Disease Control and Prevention, MMWR Morb Mortal Wkly Rep, 1999
Lessons From Past Public Health Successes

• Driver:
  – Education.
  – Licensing.
  – Limits on phone use, texting.

• Car:
  – Active: seat belts, child seats, motorcycle helmets.
  – Passive: padded interiors, collapsible steering columns, shatterproof glass, air bags.
  – Crash safety standards.
  – Safety inspections.

• Road:
  – Road engineering, guard rails, rumble strips.
  – Speed limits.
  – Stop signs, stop lights, caution signs.

• Culture:
  – Designated driver campaign.
  – Drunk-driving legislation.
  – Private advocacy, e.g. MADD.

Mozaffarian, Hemenway, & Ludwig, JAMA 2013
# Evidence-Based Policy Interventions for Diet

<table>
<thead>
<tr>
<th>Media and Education</th>
<th>• Sustained, focused media campaigns, especially combined with multi-component strategies, focused on specific foods or drinks.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labeling and Information</td>
<td>• Mandated nutrition facts, front-of-pack labels/icons, or menu labeling to influence industry behavior and product formulations.</td>
</tr>
<tr>
<td>Schools</td>
<td>• Multicomponent diet and activity program including classes, teacher training, supportive policies, environmental changes, family components.</td>
</tr>
</tbody>
</table>
| Workplaces | • Comprehensive worksite wellness programs for diet, activity, tobacco.  
• Increased availability of healthier options and/or strong nutrition standards, combined with on-site prompts, labels, or icons. |
| Economic Incentives | • Subsidy strategies to lower prices of more healthful foods and beverages.  
• Tax strategies to increase prices of less healthful foods and beverages.  
• Long-term changes in agricultural and related policies for infrastructure to facilitate production, transportation, and marketing of healthier foods. |
| Bans and Mandates | • Restrictions on ads/marketing of less healthy foods/drinks to children on television, and near schools and public places, and on packages.  
• Direct bans (e.g., sodium, trans fat) or mandates (e.g., vegetable oils). |

Mozaffarian et al, AHA Scientific Statement, Circulation 2012
# Dietary Priorities for Good Health

**EAT:**
- Fruits
- Nuts and Seeds
- Fish and Seafood
- Vegetables
- Vegetable Oils
- Whole Grains
- Moderate Dairy

**LIMIT:**
- Refined Grains, Starches, Sugars
- Processed Meats
- Sweetened Drinks
- Industrial Trans Fat
- Salt
- Alcohol

Mozaffarian, Appel, and Van Horn. Circulation 2011
### The Real Cost of Food – Dietary Taxes and Subsidies to Improve Public Health

<table>
<thead>
<tr>
<th></th>
<th>Packaged and supermarket foods</th>
<th>Restaurant and other food service establishments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simple Flat Tax</strong> (10-30%)</td>
<td>Most packaged foods (e.g., nearly all foods with a label).</td>
<td>Most chain restaurants, large cafeteria vendors, and other similar food service establishments.</td>
</tr>
<tr>
<td><strong>Subsidy</strong> (from tax revenue)</td>
<td>Minimally processed healthful foods, such as fruits, nuts, vegetables, beans, seafood, plain yogurt, vegetable oils, and minimally processed whole grains.</td>
<td>School lunch and afterschool programs.</td>
</tr>
</tbody>
</table>

Mozaffarian, Rogoff, & Ludwig, JAMA 2014