What’s Driving Disparity: The role of Health Care, Lifestyle and Social Determinants

Ali H. Mokdad, PhD
Chief Strategy Officer, Population Health
Professor, Health Metrics Sciences
Outline

1) IHME
2) Global burden of disease
3) US burden of disease
4) Other IHME projects
5) Health disparities
6) Summary and next steps
The Institute for Health Metrics and Evaluation

Independent global health research organization at the University of Washington

Focused on answering three critical questions:

• What are the world’s health problems?
• How well are we addressing these problems?
• How do we best allocate resources for maximum health impact?

You can use our data to monitor and improve health in your community.

www.healthdata.org
IHME houses the world’s most comprehensive collection of data on the incidence, prevalence, consequences, and risks of disease

Our resources:

- 550 full-time professionals in Seattle, USA
- 35+ full-time faculty
- 30-member Scientific Council
- Statisticians, data and modeling professionals
- Outreach and training personnel
- 4,300+ international collaborators
Outline

1) IHME
2) Global burden of disease
3) US burden of disease
4) Other IHME projects
5) Health disparities
6) Summary and next steps
Flashback to 1990

• Wild West of health measurement
• Conflicting claims from international programs created a false picture
  o E.g. Sum of all deaths = world’s population died four times over
• Comparable information on non-fatal health outcomes was nonexistent
• Without good evidence, good decisions were impossible

Rigorous methods needed to create good evidence from imperfect data.
Global Burden of Disease today

• A systematic, scientific effort to quantify the comparative magnitude of health loss from all major diseases, injuries, and risk factors by age, sex, and population and over time

• Covers 195 countries and territories from 1990 to present. Subnational assessments for some countries including Indonesia, China, India, USA, Russia, UK

• 359 diseases and injuries, 3,228 sequelae, 84 risk factors or clusters of risk factors

• Time series from 1990 to most recent year, updated annually

• Findings published in major medical journals, policy reports, and online data visualizations
Multiple metrics for health to facilitate different types of uses

1) **Traditional metrics**: Disease and injury prevalence and incidence, death numbers and rates.

2) **Years of life lost** due to premature mortality (YLLs) – count the number of years lost at each age compared to a reference life expectancy of 86 at birth.

3) **Years lived with disability** (YLDs) for a cause in an age-sex group equals the prevalence of the condition times the disability weight for that condition.

4) **Disability-adjusted life years (DALYs)** are the sum of YLLs and YLDs and are an overall metric of the burden of disease.

5) **Healthy life expectancy (HALE)** is a positive summary measure counting the expected years of life in full health.
Diseases and injuries in the GBD datasets form a hierarchy of 333 causes, mutually exclusive and exhaustive, of all-cause mortality.

### Group I: Communicable, maternal, neonatal, nutritional diseases
- HIV/AIDS and tuberculosis
- Diarrhea, lower respiratory, other common infectious diseases
- Neglected tropical diseases and malaria
- Maternal disorders
- Neonatal disorders
- Nutritional deficiencies
- Other communicable, maternal, neonatal, nutritional diseases

### Group II: Non-communicable diseases
- Neoplasms (cancers)
- Cardiovascular diseases
- Chronic respiratory diseases
- Cirrhosis and other chronic liver diseases
- Digestive diseases
- Neurological disorders
- Mental and substance use disorders
- Diabetes, urogenital, blood, endocrine diseases
- Musculoskeletal disorders
- Other non-communicable diseases

### Group III: Injuries
- Transport injuries
- Unintentional injuries
- Self-harm and interpersonal violence
- Forces of nature, war, legal intervention

Higher-level group data can be interrogated in progressively greater detail:

- **Neoplasms (cancers)**
  - Esophageal cancer
  - Stomach cancer
  - Colon and rectum cancer
  - Liver cancer
  - Gallbladder and biliary tract cancer
  - Pancreatic cancer
  - Larynx cancer
  - Tracheal, bronchus, lung cancer
  - Malignant skin melanoma
  - Non-melanoma skin cancer
  - Breast cancer
  - ...

- **Liver cancers**
  - Liver cancer due to hepatitis B
  - Liver cancer due to hepatitis C
  - Liver cancer due to alcohol use
  - Liver cancer due to other causes

- **Drug use disorders**
  - Opioid use disorders
  - Cocaine use disorders
  - Amphetamine use disorders
  - Cannabis use disorders
  - Other drug use disorders

- **Mental and substance use disorders**
  - Schizophrenia
  - Alcohol use disorders
  - Drug use disorders
  - Depressive disorders
  - Bipolar disorder
  - Anxiety disorder
  - Eating disorders
  - Autistic spectrum disorders
  - Attention-deficit/hyperactivity disorder
  - Conduct disorder
  - ...

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# 84 risk factors

## Environmental/occupational risks

<table>
<thead>
<tr>
<th>Level</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Environmental/occupational risks</td>
</tr>
<tr>
<td>2</td>
<td>Unsafe water, sanitation, and handwashing</td>
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<tr>
<td>3</td>
<td>Unsafe water source</td>
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<tr>
<td>3</td>
<td>Unsafe sanitation</td>
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<tr>
<td>3</td>
<td>No access to handwashing facility</td>
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<td>2</td>
<td>Air pollution</td>
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<td>3</td>
<td>Ambient particulate matter pollution</td>
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<td>Household air pollution from solid fuels</td>
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<td>3</td>
<td>Ambient ozone pollution</td>
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<td>2</td>
<td>Other environmental risks</td>
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<td>3</td>
<td>Residential radon</td>
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<td>Lead exposure</td>
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<td>2</td>
<td>Occupational risks</td>
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<tr>
<td>3</td>
<td>Occupational carcinogens</td>
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<tr>
<td>4</td>
<td>Occupational exposure to arsenic</td>
</tr>
<tr>
<td>4</td>
<td>Occupational exposure to asbestos</td>
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<tr>
<td>4</td>
<td>Occupational exposure to benzene</td>
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<tr>
<td>4</td>
<td>Occupational exposure to beryllium</td>
</tr>
<tr>
<td>4</td>
<td>Occupational exposure to cadmium</td>
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<tr>
<td>4</td>
<td>Occupational exposure to chromium</td>
</tr>
<tr>
<td>4</td>
<td>Occupational exposure to diesel engine exhaust</td>
</tr>
<tr>
<td>4</td>
<td>Occupational exposure to formaldehyde</td>
</tr>
<tr>
<td>4</td>
<td>Occupational exposure to nickel</td>
</tr>
<tr>
<td>4</td>
<td>Occupational exposure to polycyclic aromatic hydrocarbons</td>
</tr>
<tr>
<td>4</td>
<td>Occupational exposure to secondhand smoke</td>
</tr>
<tr>
<td>4</td>
<td>Occupational exposure to silica</td>
</tr>
<tr>
<td>4</td>
<td>Occupational exposure to sulfuric acid</td>
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<td>4</td>
<td>Occupational exposure to trichloroethylene</td>
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<td>3</td>
<td>Occupational asthmagens</td>
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<td>3</td>
<td>Occupational ergonomic factors</td>
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<tr>
<td>3</td>
<td>Occupational injuries</td>
</tr>
<tr>
<td>3</td>
<td>Occupational noise</td>
</tr>
<tr>
<td>3</td>
<td>Occupational particulate matter, gases, and fumes</td>
</tr>
</tbody>
</table>

## Behavioral risks

<table>
<thead>
<tr>
<th>Level</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Behavioral risks</td>
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<tr>
<td>2</td>
<td>Child and maternal malnutrition</td>
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<td>3</td>
<td>Suboptimal breastfeeding</td>
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<td>Non-exclusive breastfeeding</td>
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<td>4</td>
<td>Discontinued breastfeeding</td>
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<td>3</td>
<td>Child growth failure</td>
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<td>4</td>
<td>Child underweight</td>
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<tr>
<td>4</td>
<td>Child wasting</td>
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<tr>
<td>4</td>
<td>Child stunting</td>
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<tr>
<td>3</td>
<td>Low birth weight and short gestation</td>
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<td>4</td>
<td>Short gestation for birth weight</td>
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<tr>
<td>4</td>
<td>Low birth weight for gestation</td>
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<td>3</td>
<td>Iron deficiency</td>
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<td>Vitamin A deficiency</td>
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<td>Zinc deficiency</td>
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<td>Tobacco</td>
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<td>Smoking</td>
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<td>Smokeless tobacco</td>
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<td>3</td>
<td>Secondhand smoke</td>
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<td>2</td>
<td>Alcohol and drug use</td>
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<td>Alcohol use</td>
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<tr>
<td>3</td>
<td>Drug use</td>
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<tr>
<td>2</td>
<td>Dietary risks</td>
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<tr>
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<td>Diet high in processed meat</td>
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<td>Diet high in red meat</td>
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<td>Diet high in sodium</td>
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<td>Diet high in sugar-sweetened beverages</td>
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<td>Diet high in trans fatty acids</td>
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<td>3</td>
<td>Diet low in calcium</td>
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<td>3</td>
<td>Diet low in fiber</td>
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<td>Diet low in fruits</td>
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<td>Diet low in legumes</td>
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<td>3</td>
<td>Diet low in milk</td>
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<td>3</td>
<td>Diet low in nuts and seeds</td>
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<tr>
<td>3</td>
<td>Diet low in polyunsaturated fatty acids</td>
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<td>3</td>
<td>Diet low in seafood omega-3 fatty acids</td>
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<td>Diet low in vegetables</td>
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<tr>
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<td>Diet low in whole grains</td>
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<tr>
<td>2</td>
<td>Sexual abuse and violence</td>
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<td>3</td>
<td>Childhood sexual abuse</td>
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<td>3</td>
<td>Intimate partner violence</td>
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<tr>
<td>2</td>
<td>Unsafe sex</td>
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<tr>
<td>2</td>
<td>Low physical activity</td>
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</tbody>
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## Metabolic risks

<table>
<thead>
<tr>
<th>Level</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Metabolic risks</td>
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<tr>
<td>2</td>
<td>High fasting plasma glucose</td>
</tr>
<tr>
<td>2</td>
<td>High total cholesterol</td>
</tr>
<tr>
<td>2</td>
<td>High systolic blood pressure</td>
</tr>
<tr>
<td>2</td>
<td>High body mass index</td>
</tr>
<tr>
<td>2</td>
<td>Low bone mineral density</td>
</tr>
<tr>
<td>2</td>
<td>Impaired kidney function</td>
</tr>
</tbody>
</table>
Increased transparency

- GBD 1990 analysis was published in two volumes (1000+ pp); neither the primary data nor the spreadsheets used were made available (for various reasons); limited methodological detail published.

- Subsequently, public debate about strengthening global health metrics led to the creation of the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER).

- As of GBD 2015, all GBD studies are GATHER-compliant: we release documentation for each source, provide an online searchable catalog of the more than 100,000 sources used, and post the code for each step in the analysis.
GBD Compare data viz (vizhub.healthdata.org/gbd-compare)
Visualization translated into Chinese, English, French, Italian, Japanese, Norwegian, Portuguese, Russian, Spanish, Swedish
Clinical informatics – background

IHME Clinical Informatics database

• One of seven core inputs to GBD estimation.
• Records include inpatient admissions, outpatient clinic visits, and health insurance claims records.
• Information includes diagnosis codes, procedure codes, demographic information, mortality outcomes.
• Steadily increasing volume of data from GBD 2010 through GBD 2019.
• Database represents 7 billion clinical encounters from 47 countries.
Sociodemographic Index (SDI)

Components
• Economic Capital + Human Capital + Demographics

Indicators
• Economic Capital: GBD per capita (Lag dependent)
• Human Capital: Average educational attainment of population over 15 (both sexes)
• Demographics: Under 25 fertility rate

Calculation
• Same as development index; equal weight to all 3 indicators and re-scale to 0-1 using geometric mean
• Reported in quintiles

Yohannes Kinfu
GBD Collaborator

Suggested change to SDI instead of “developing” / “developed”
Expected relationship between all-age YLL and YLD rates and SDI for 21 causes

- Forces of nature, conflict and terrorism, and executions and police conflict
- Self-harm and interpersonal violence
- Unintentional injuries
- Transport injuries
- Other non-communicable diseases
- Musculoskeletal disorders
- Diabetes, urogenital, blood, and endocrine diseases
- Mental and substance use disorders
- Neurological disorders
- Digestive diseases
- Cirrhosis and other chronic liver diseases
- Chronic respiratory diseases
- Cardiovascular diseases
- Neoplasms
- Other communicable, maternal, neonatal, and nutritional diseases
- Nutritional deficiencies
- Neonatal disorders
- Maternal disorders
- Neglected tropical diseases and malaria
- Diarrhoea, lower respiratory infections, and other common infectious diseases
- HIV/AIDS-tuberculosis
Ratio of observed-to-expected age-standardized DALY rates on the basis of SDI alone, 2016
Outline

1) IHME
2) Global burden of disease
3) US burden of disease
4) Other HME projects
5) Health disparities
6) Summary and next steps
Burden of Diseases, Injuries, and Risk Factors Among US States

The US Burden of Disease Collaborators

INTRODUCTION Several studies have measured health outcomes in the United States, but none have provided a comprehensive assessment of patterns of health by state.

OBJECTIVE To use the results of the Global Burden of Disease Study (GBD) to report trends in the burden of diseases, injuries, and risk factors at the state level from 1990 to 2016.

DESIGN AND SETTING A systematic analysis of published studies and available data sources estimates the burden of disease by age, sex, geography, and year.

MAIN OUTCOMES AND MEASURES Prevalence, incidence, mortality, life expectancy, healthy life expectancy (HALE), years of life lost (YLLs) due to premature mortality, years lived with disability (YLDs), and disability-adjusted life-years (DALYs) for 333 causes and 84 risk factors with 95% uncertainty intervals (UIs) were computed.
Top 25 causes of DALYs, 1990-2016

<table>
<thead>
<tr>
<th>Leading causes of DALYs, 1990</th>
<th>Leading causes of DALYs, 2016</th>
<th>No. of DALYs</th>
<th>All-Age DALY Rate</th>
<th>Age-Standardized DALY Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ischemic heart disease</td>
<td>1 Lung cancer</td>
<td>-18.3 (-20.5 to -16.1)</td>
<td>-36.7 (-38.4 to -35.0)</td>
<td>-49.7 (-51.1 to -48.3)</td>
</tr>
<tr>
<td>2 Lung cancer</td>
<td>2 Lung cancer</td>
<td>14.1 (10.7 to 17.1)</td>
<td>11.6 (-14.2 to -8.8)</td>
<td>32.5 (-34.5 to -30.4)</td>
</tr>
<tr>
<td>3 COPD</td>
<td>3 COPD</td>
<td>71.7 (66.2 to 78.7)</td>
<td>33.1 (28.9 to 38.5)</td>
<td>5.5 (2.2 to 9.7)</td>
</tr>
<tr>
<td>4 Diabetes</td>
<td>4 Diabetes</td>
<td>75.6 (67.1 to 83.9)</td>
<td>36.1 (29.3 to 42.5)</td>
<td>11.0 (5.7 to 16.2)</td>
</tr>
<tr>
<td>5 Low back pain</td>
<td>5 Low back pain</td>
<td>25.1 (10.9 to 39.6)</td>
<td>-3.1 (-14.1 to 8.2)</td>
<td>-12.1 (-22.3 to -1.9)</td>
</tr>
<tr>
<td>6 Alzheimer disease</td>
<td>6 Alzheimer disease</td>
<td>75.7 (63.4 to 88.2)</td>
<td>36.1 (26.6 to 45.8)</td>
<td>4.0 (-2.5 to 10.8)</td>
</tr>
<tr>
<td>7 Major depression</td>
<td>7 Major depression</td>
<td>74.5 (42.8 to 93.8)</td>
<td>35.2 (10.6 to 50.1)</td>
<td>47.9 (21.8 to 64.1)</td>
</tr>
<tr>
<td>8 Other musculoskeletal</td>
<td>8 Other musculoskeletal</td>
<td>32.2 (23.2 to 41.5)</td>
<td>2.4 (-4.6 to 9.6)</td>
<td>-2.6 (-9.0 to 3.6)</td>
</tr>
<tr>
<td>9 Migraine</td>
<td>9 Migraine</td>
<td>27.1 (21.6 to 32.7)</td>
<td>-1.5 (-5.8 to 2.8)</td>
<td>0.1 (-4.1 to 3.7)</td>
</tr>
<tr>
<td>10 Ischemic stroke</td>
<td>10 Ischemic stroke</td>
<td>27.2 (25.3 to 29.1)</td>
<td>-1.4 (-3.0 to 0.0)</td>
<td>-1.4 (-2.8 to -0.1)</td>
</tr>
<tr>
<td>11 Opioid use disorders</td>
<td>11 Opioid use disorders</td>
<td>55.3 (39.2 to 73.3)</td>
<td>20.3 (7.8 to 34.2)</td>
<td>3.3 (-7.5 to 15.0)</td>
</tr>
<tr>
<td>12 Alzheimer disease</td>
<td>12 Alzheimer disease</td>
<td>26.3 (21.3 to 31.1)</td>
<td>-2.2 (-6.0 to 1.6)</td>
<td>-22.4 (-25.5 to -19.4)</td>
</tr>
<tr>
<td>13 HIV/AIDS other</td>
<td>13 HIV/AIDS other</td>
<td>87.5 (68.4 to 97.5)</td>
<td>45.3 (30.5 to 53.0)</td>
<td>19.0 (8.5 to 24.5)</td>
</tr>
<tr>
<td>14 Anxiety disorders</td>
<td>14 Anxiety disorders</td>
<td>30.8 (25.7 to 36.0)</td>
<td>1.4 (-2.6 to 5.4)</td>
<td>0.6 (-3.2 to 4.5)</td>
</tr>
<tr>
<td>15 Neonatal preterm birth</td>
<td>15 Motor vehicle road injury</td>
<td>-16.5 (-20.3 to -12.2)</td>
<td>-35.3 (-38.3 to -31.9)</td>
<td>-35.0 (-37.7 to -31.8)</td>
</tr>
<tr>
<td>16 Colorectal cancer</td>
<td>16 Colorectal cancer</td>
<td>72.5 (67.3 to 78.3)</td>
<td>33.6 (29.6 to 38.1)</td>
<td>9.8 (6.6 to 13.4)</td>
</tr>
<tr>
<td>17 Colorectal cancer</td>
<td>17 Colorectal cancer</td>
<td>16.6 (12.4 to 20.9)</td>
<td>-9.7 (-12.9 to -6.3)</td>
<td>-27.4 (-29.9 to -24.7)</td>
</tr>
<tr>
<td>18 Breast cancer</td>
<td>18 Lower respiratory infection</td>
<td>27.7 (21.8 to 33.7)</td>
<td>-1.0 (-5.6 to 3.5)</td>
<td>-18.8 (-22.3 to -15.2)</td>
</tr>
<tr>
<td>19 Lower respiratory infection</td>
<td>19 Intracerebral hemorrhage</td>
<td>31.6 (26.1 to 36.4)</td>
<td>2.0 (-2.3 to 5.6)</td>
<td>-17.0 (-20.4 to -14.1)</td>
</tr>
<tr>
<td>20 Intracerebral hemorrhage</td>
<td>20 Breast cancer</td>
<td>6.1 (1.1 to 11.4)</td>
<td>-17.8 (-21.5 to -13.7)</td>
<td>-34.3 (-37.3 to -31.1)</td>
</tr>
<tr>
<td>21 Falls</td>
<td>21 Diabetes CKD</td>
<td>127.6 (118.7 to 136.8)</td>
<td>76.3 (69.5 to 83.5)</td>
<td>44.3 (39.5 to 49.5)</td>
</tr>
<tr>
<td>22 Age-related hearing loss</td>
<td>22 Self-harm by other means</td>
<td>49.2 (23.3 to 58.9)</td>
<td>15.6 (-4.5 to 23.1)</td>
<td>20.3 (-0.5 to 28.0)</td>
</tr>
<tr>
<td>23 Acne vulgaris</td>
<td>23 Alcohol use disorders</td>
<td>30.8 (23.9 to 39.5)</td>
<td>1.3 (-5.2 to 8.1)</td>
<td>-0.2 (-5.8 to 5.7)</td>
</tr>
<tr>
<td>24 Self-harm by firearm</td>
<td>24 Osteoarthritis</td>
<td>75.3 (68.5 to 82.6)</td>
<td>35.8 (30.5 to 41.5)</td>
<td>8.0 (3.7 to 12.5)</td>
</tr>
<tr>
<td>25 Violence by firearm</td>
<td>25 Acne vulgaris</td>
<td>16.0 (14.3 to 17.8)</td>
<td>-10.1 (-11.4 to -8.7)</td>
<td>-1.5 (-3.0 to 0.2)</td>
</tr>
</tbody>
</table>

*Communicable, maternal, neonatal, and nutritional diseases
Noncommunicable diseases
Injuries
% of DALYs related to the 17 leading risk factors in the US, 2016

Risk factors
- Tobacco use
- High body mass index
- Dietary risks
- Alcohol and drug use
- High fasting plasma glucose
- High systolic blood pressure
- High total cholesterol
- Impaired kidney function
- Occupational risks
- Air pollution
- Low physical activity
- Child and maternal malnutrition
- Low bone mineral density
- Unsafe sex
- Sexual abuse and violence
- Residential radon and lead exposure
- Unsafe water, sanitation, and handwashing

Disability-Adjusted Life-Years, %
Change in Probability of Death, Ages 0-20, 1990-2016

United States
Mississippi
Alabama
Louisiana
Oklahoma
Arkansas
West Virginia
South Dakota
Tennessee
South Carolina

Minnesota
Rhode Island
Vermont
Washington
New York
New Hampshire
Connecticut
California
New Jersey
Massachusetts

Noncommunicable diseases
- Neoplasms
- Cardiovascular diseases
- Chronic respiratory diseases
- Cirrhosis and other chronic liver diseases
- Digestive diseases
- Neurological disorders
- Mental and substance use disorders
- Diabetes, urogenital, blood, and endocrine diseases
- Musculoskeletal disorders
- Other noncommunicable diseases

Communicable, maternal, neonatal, and nutritional diseases
- HIV/AIDS and tuberculosis
- Diarrhea, lower respiratory tract, and other common infectious diseases
- Neglected tropical diseases and malaria
- Maternal disorders
- Neonatal disorders
- Nutritional deficiencies
- Other communicable, maternal, neonatal, and nutritional diseases

Injuries
- Transport injuries
- Unintentional injuries
- Self-harm and interpersonal violence
- Forces of nature, conflict and terrorism, and executions and police conflict

Sum of decreases in probability of death, 1990-2016: -0.7
Decrease from 1990: +0.0
Increase from 1990: +0.0

Sum of increases in probability of death, 1990-2016:

Institute for Health Metrics and Evaluation
Change in Probability of Death, Ages 20-55, 1990-2016

United States
West Virginia
Mississippi
Alabama
Oklahoma
Kentucky
Arkansas
New Mexico
Louisiana
Tennessee
South Carolina
Alaska
Missouri
Wyoming
Indiana
Ohio

New Jersey
Connecticut
New York
California
Minnesota

Noncommunicable diseases
Neoplasms
Cardiovascular diseases
Chronic respiratory diseases
Cirrhosis and other chronic liver diseases
Digestive diseases
Neurological disorders
Mental and substance use disorders
Diabetes, urogenital, blood, and endocrine diseases
Musculoskeletal disorders
Other noncommunicable diseases

Communicable, maternal, neonatal, and nutritional diseases
HIV/AIDS and tuberculosis
Diarrhea, lower respiratory tract, and other common infectious diseases
Neglected tropical diseases and malaria
Maternal disorders
Neonatal disorders
Nutritional deficiencies
Other communicable, maternal, neonatal, and nutritional diseases

Injuries
Transport injuries
Unintentional injuries
Self-harm and interpersonal violence
Forces of nature, conflict and terrorism, and executions and police conflict

Sum of decreases in probability of death, 1990-2016
Decrease from 1990
Increase from 1990
Sum of increases in probability of death, 1990-2016

Institute for Health Metrics and Evaluation
Change in Probability of Death, Ages 55-90, 1990-2016

United States
Mississippi
West Virginia
Alabama
Kentucky
Louisiana
Arkansas
Oklahoma
Tennessee
Georgia

South Dakota
Colorado
Minnesota
North Dakota
New York
Connecticut
Arizona
Florida
California
Hawaii

Institute for Health Metrics and Evaluation
Raking causes by DALYs

<table>
<thead>
<tr>
<th>State</th>
<th>Tobacco use</th>
<th>High body mass index</th>
<th>Dietary risks</th>
<th>Alcohol and drug use</th>
<th>High fasting plasma glucose</th>
<th>High systolic blood pressure</th>
<th>High total cholesterol</th>
<th>Impaired kidney function</th>
<th>Occupational risks</th>
<th>Air pollution</th>
<th>Low physical activity</th>
<th>Child and maternal malnutrition</th>
<th>Low bone mineral density</th>
<th>Unsafe sex</th>
<th>Sexual abuse and violence</th>
<th>Residential radon and lead exposure</th>
<th>Unsafe water, sanitation, and handwashing</th>
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</tbody>
</table>
Outline

1) IHME
2) Global burden of disease
3) US burden of disease
4) Other IHME projects
5) Health disparities
6) Summary and next steps
Sustainable Development Goals
Health-related SDG index, by decile, in 2017

Singapore 85, USA 74 (21), Central African Republic 12 (195)
Subnational Health-related SDG index, by decile, in 2017
Health Access and Quality Index (HAQ Index)

- 32 causes which, in the presence of functioning health systems, should not result in death
  - Ex: breast cancer, tetanus, diarrhea in children under 14...
- Incidence – Mortality Ratio
- Risk-standardize
- Create an index (0 – 100) to measure access and quality of health systems
National performance on the HAQ Index, 2016

Iceland 97, US 89 (29), Central African Republic 19 (195)
Map of HAQ Index values for selected subnational locations in 2016

Source: Fullman N, et al. 2018
human capital Index

- Its calculation combines:
  - Expected years lived between the ages of 20 and 64, which are then adjusted for the next component: functional health status. Functional health status – scaled from 0 to 100 – is based on seven conditions known to impact learning and productivity.

  *With*

  - Years of completed education (from 0 to 18), which are then adjusted by the next component: learning. Learning – scaled from 0 to 100 – is based on average student scores on internationally comparable tests.

- The highest possible score is 45 and the lowest is 0.
What is the current picture?

Map of expected human capital by country in 2016

Finland 28, US 23 (27), Niger 2 (195)
Why does it matter?

• Higher expected human capital is correlated with higher national gross domestic product (GDP).

• Countries whose expected human capital has increased the most since 1990 have also tended to experience faster growth in their GDP per person.
  o Countries in the top 25% of human capital improvement between 1990 and 2016 had a 1.1% higher annual GDP growth rate than those in the bottom 25% of human capital improvement.
Disease Expenditure project – payer split

DUBE = Diabetes, urogenital, blood, and endocrine disorders
Application 1: Decomposition of increases in spending

Inpatient spending

- Population: $96 billion↑
- Age: $52 billion↑
- Prevalence: $14 billion↓
- Utilization: $212 billion↓
- Price: $336 billion↑

Outpatient spending

- Population: $87 billion↑
- Age: $31 billion↑
- Prevalence: $9 billion↓
- Utilization: $110 billion↑
- Price: $101 billion↑

Change in annual spending 1996-2013 (billions)
Disease expenditure project: vizhub.healthdata.org/dex/
Stunting among children under 5
GBD future health scenarios

1) GBD forecasts and alternative scenarios for 195 countries to 2040 published Lancet October 17, 2018.

2) Model is a causal model (79 independent drivers) with good out-of-time predictive validity.

3) Reference scenario: statistically most likely outcome given past trends and relationships

4) Better scenario: what could happen if a country achieved the 85th percentile across countries rate of change in each of the drivers.

5) Worse scenario: what could happen if a country achieved the 15th percentile across countries in rates of change in the drivers
High body mass index in the US, age-standardized, 1990–2040
High blood pressure in the US, age-standardized, 1990–2040
Smoking in the US, age-standardized, 1990–2040
US ranking in life expectancy dropping and will continue to drop
Leading 20 risk factors in the US contributing to the difference in years of life lost between reference, better health, and worse health scenarios, 2040
Outline

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Healthy Life expectancy (by state 2017)

Hawaii 69.7, Minnesota 69.4, Cuba 69.2, Guatemala 63.5, WV 62.5, Haiti 56.3
Life expectancy (by state, 2014)

- 75 years in Mississippi
- 81 years in Hawaii

Life expectancy at birth (years):

- 66
- 69
- 72
- 75
- 78
- 81
- 84
- 87
Life expectancy (by county, 2014)

67 years in Oglala Lakota, SD

87 years in Summit, CO
Geographic inequality: life expectancy
Tract-level life expectancy in King County, WA

http://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(17)30165-2/fulltext

IHME | UNIVERSITY of WASHINGTON
Tracheal, bronchus, and lung cancer
Results: Smoking

Current smoking prevalence, 2012

<table>
<thead>
<tr>
<th>Males</th>
<th>Females</th>
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</thead>
<tbody>
<tr>
<td>[Map of Males]</td>
<td>[Map of Females]</td>
</tr>
</tbody>
</table>

IHME | UNIVERSITY of WASHINGTON
Testicular cancer
Breast cancer (females only)
Causes of death: self-harm
Causes of death: drug use disorders
Binge drinking: prevalence, 2012
What are the drivers of these disparities?

• Socioeconomic inequalities
• Lack of financial access to health care
• Poor quality of care
• Preventable causes of death
## Potential drivers of inequality in life expectancy

<table>
<thead>
<tr>
<th>Socioeconomic &amp; race/ethnicity factors</th>
<th>Behavioral &amp; metabolic risk factors</th>
<th>Health care access &amp; quality factors</th>
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<tbody>
<tr>
<td>Poverty (%)</td>
<td>Obesity (%)</td>
<td>Insurance (%)</td>
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<tr>
<td>Median income (log $)</td>
<td>Physical inactivity (%)</td>
<td>Quality</td>
</tr>
<tr>
<td>High school education (%)</td>
<td>Smoking (%)</td>
<td>Medical doctors (per 1,000 population)</td>
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<tr>
<td>College education (%)</td>
<td>Hypertension (%)</td>
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<tr>
<td>Unemployment (%)</td>
<td>Diabetes (%)</td>
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<td>Black (%)</td>
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<td>American Indian/Alaska Native (%)</td>
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<td>Hispanic (%)</td>
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## Potential drivers of inequality in life expectancy

<table>
<thead>
<tr>
<th></th>
<th>SES only</th>
<th>Risks only</th>
<th>Care only</th>
<th>Combined</th>
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<tr>
<td>(Intercept)</td>
<td>70.60* (0.10)</td>
<td>70.40* (0.08)</td>
<td>73.21* (0.13)</td>
<td>70.07* (0.09)</td>
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<tr>
<td>SES index</td>
<td>13.13* (0.19)</td>
<td>-0.10 (0.37)</td>
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<td>Risk index</td>
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<td>13.73* (0.15)</td>
<td>13.04* (0.33)</td>
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<tr>
<td>Care index</td>
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<td>7.88* (0.23)</td>
<td>1.37* (0.17)</td>
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<td>R-squared</td>
<td>0.60</td>
<td>0.74</td>
<td>0.27</td>
<td>0.74</td>
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</table>

*p < 0.05
Outline

1) IHME
2) Global burden of disease
3) US burden of disease
4) Other IHME projects
5) Health disparities
6) Summary and next steps
Big picture in the US

1. Regardless of the metric of population health, the US performs poorly relative to other high-income countries.

2. Most communities in the US are steadily falling behind each year compared to other high-income nations.

3. Females are falling behind faster than males in most parts of the country.

4. We have many health disparities in the US, Washington, and King County.

5. A large number of deaths and a large component of disparities could be addressed by modification of major risk factors through primary care and community interventions.
Focus on Preventable Risks

1. Reducing socio-economic inequalities, expanding insurance, improving quality are all important goals and can improve health and reduce disparities.

2. Focusing on preventable risks is likely to be more cost-effective: bigger potential benefits, neglected in many communities and less costly than other strategies.
Empower Local Innovative Strategies to Reduce Risks

1. Given the diversity of risks and communities, no simple menu of effective programs for risk reduction.
2. Local experimentation to figure out what works in a given community is likely to be necessary.
3. Fund innovative strategies and document through independent evaluation whether they work or do not.
Engage Medical Providers in Accountable Care

1. Many leading risks (tobacco, blood pressure, blood sugar, cholesterol, alcohol intake, physical inactivity, components of diet) there is an important role for primary health care.

2. Need to broaden the notion of accountability beyond providing high quality care to encompass achieving risk reduction in partnership with patients.

3. Forging a connection between healthcare provision and progress for individuals and communities in health outcomes will be critical for the future.
Key questions for Americans’ health

• What are the future magnitude and trends of disease burden?
• Are there disparities among certain population groups?
• What are the health care costs, health spending, and fiscal impact – plus other non-health-care costs (disability, early retirement, absenteeism, etc.)?
• What are the key drivers of both the increased disease burden and the increased health expenditure?
• What are potential interventions or campaigns for addressing these shifts in disease?
Burden of US Health Disparities Project

- Three year contract with NIH’s National Institute of Minority Health and Disparities
- Goal: to highlight disparities in health outcomes across race/ethnicity and socio-economic groups in the US, including measures related to mortality, incidence, prevalence and the impact of diseases, injuries, and risk factors
- Collaboration with multi-institute US Health Disparities Working Group
- Seeking additional funding from other US-focused funders to continue to grow and expand work on burden, health expenditure, future health scenarios, and policy-relevant findings.
Burden of US Health Disparities Project

• Major deliverables:
  o County-level estimates of mortality, incidence, prevalence and morbidity from leading causes of disease, injury and risk factors by age, sex, race/ethnicity, and socioeconomic status (SES).
    ─ Selected non-fatal causes and risk factors to be selected in coordination with Working Group based on data availability
  o A report detailing findings and a public platform for download of the data
  o Evaluation of the feasibility of producing census tract-level estimates by race/ethnicity in four metropolitan areas
Qualitative approaches: GRADE

GRADE (Grading of Recommendations, Assessment, Development, and Evaluations) is a transparent framework for developing and presenting summaries of evidence that provides a systematic approach for making clinical practice recommendations.

It is the most widely adopted tool for grading the quality of evidence and for making recommendations, with over 100 organizations worldwide officially endorsing GRADE.

GRADE is subjective.

<table>
<thead>
<tr>
<th>Certainty</th>
<th>What it means</th>
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<tbody>
<tr>
<td>Very low</td>
<td>The true effect is probably markedly different from the estimated effect</td>
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<tr>
<td>Low</td>
<td>The true effect might be markedly different from the estimated effect</td>
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<tr>
<td>Moderate</td>
<td>The authors believe that the true effect is probably close to the estimated effect</td>
</tr>
<tr>
<td>High</td>
<td>The authors have a lot of confidence that the true effect is similar to the estimated effect</td>
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</table>
GBD to date uses World Cancer Research Fund criteria to assess evidence.

Highly subjective

<table>
<thead>
<tr>
<th>Bradford Hill’s Criteria</th>
<th>WCRF Criteria</th>
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<tbody>
<tr>
<td><strong>Consistency</strong></td>
<td><strong>Convincing</strong></td>
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<tr>
<td>Evidence from more than one study type. No substantial unexplained heterogeneity within or between study types or in different populations relating to the presence or absence of an association, or direction of effect.</td>
<td>No substantial unexplained heterogeneity between or within study types in the presence or absence of an association, or direction of effect.</td>
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<tr>
<td><strong>Temporality</strong></td>
<td>Evidence from at least two independent cohort studies.</td>
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<td><strong>Experiment</strong></td>
<td>Strong and plausible experimental evidence, either from human studies or relevant animal models, that typical human exposures can lead to relevant cancer outcomes.</td>
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<tr>
<td><strong>Biological gradient</strong></td>
<td>Presence of a plausible biological gradient (“dose response”) in the association. Such a gradient need not be linear or even in the same direction across the different levels of exposure so long as this can be explained plausibly.</td>
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<tr>
<td><strong>Plausibility</strong></td>
<td>Evidence for biological plausibility.</td>
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<td><strong>Strength</strong></td>
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<td><strong>Analogy</strong></td>
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<td><strong>Coherence</strong></td>
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<td><strong>Specificity</strong></td>
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<tr>
<td><strong>Good-quality studies to exclude with confidence the possibility that the observed association results from random or systematic error, including confounding, measurement error, and selection bias.</strong></td>
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Star rating system

Convert the probability of a null effect, taking into account between-study heterogeneity that cannot be explained by risk of bias to a categorical rating for ease of communication.

- **5 stars** – p<0.001
- **4 stars** – p<0.01
- **3 stars** – p<0.05
- **2 stars** – p<0.2
- **1 star** – p<0.5

These are very “inclusive” criteria. Pros are that risk-outcome pairs people expect are included. Cons are that risk-outcome pairs that are effectively a coin toss for causal relationships may be included.

Exact thresholds may be revised based on more experience with analyzing a wider range of risk-outcome pairs.
Future area of research for Americans

• Conduct situational analysis by forecasting burden of disease and health expenditure to 2050
• Gather all available literature
• Develop evidence syntheses
• Develop a predictive intervention model
• Provide a visualization for translation of results
Concept

- Leverage GBD work and forecasting to identify priorities
- Comprehensive approach: review and synthesize all interventions evidence and cost
- Prioritize budget allocation for maximum impact with best strategies given local situation

DONE  MISSING  PILOTED
Translation Model
Thank you!

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