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Health-Care Spending Attributable to Modifiable Risk Factors in the U.S.A

An Economic Attribution Analysis

Discovery Ltd; Vitality Group International

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Agenda

Chapter 1
Associations

Lifetime Course of Chronic Disease and Aging

The causative relationships among risk factors and health outcomes are complex, necessitating a framework with which to understand the relationships between causes (unhealthy lifestyle behaviors and heightened biometric risk) and consequences (medical conditions and deaths).

Chapter 2
Attribution

A Framework to Help Guide the Relationships Between Risk and Disease

The framework presented quantifies health loss metrics for 286 causes of death, 369 diseases and injuries, and 87 risk factors.

It provides the foundation for quantifying health-care spending attributable to modifiable risks, which is the basis of *The Lancet Public Health Paper* explored in this presentation, illustrating that reducing modifiable risk factors has strong potential to significantly reduce health-care spending.

Chapter 3
Applications

Creating Business Models that Address Risk and Disease

There is a shift towards purpose-driven business models, which are being embraced by diverse industries.

With the nature of risk becoming more behavioral, technology serving as an enabler, and people expecting more from organizations, the forces driving the insurance landscape are changing, presenting new opportunities.

Chapter 1

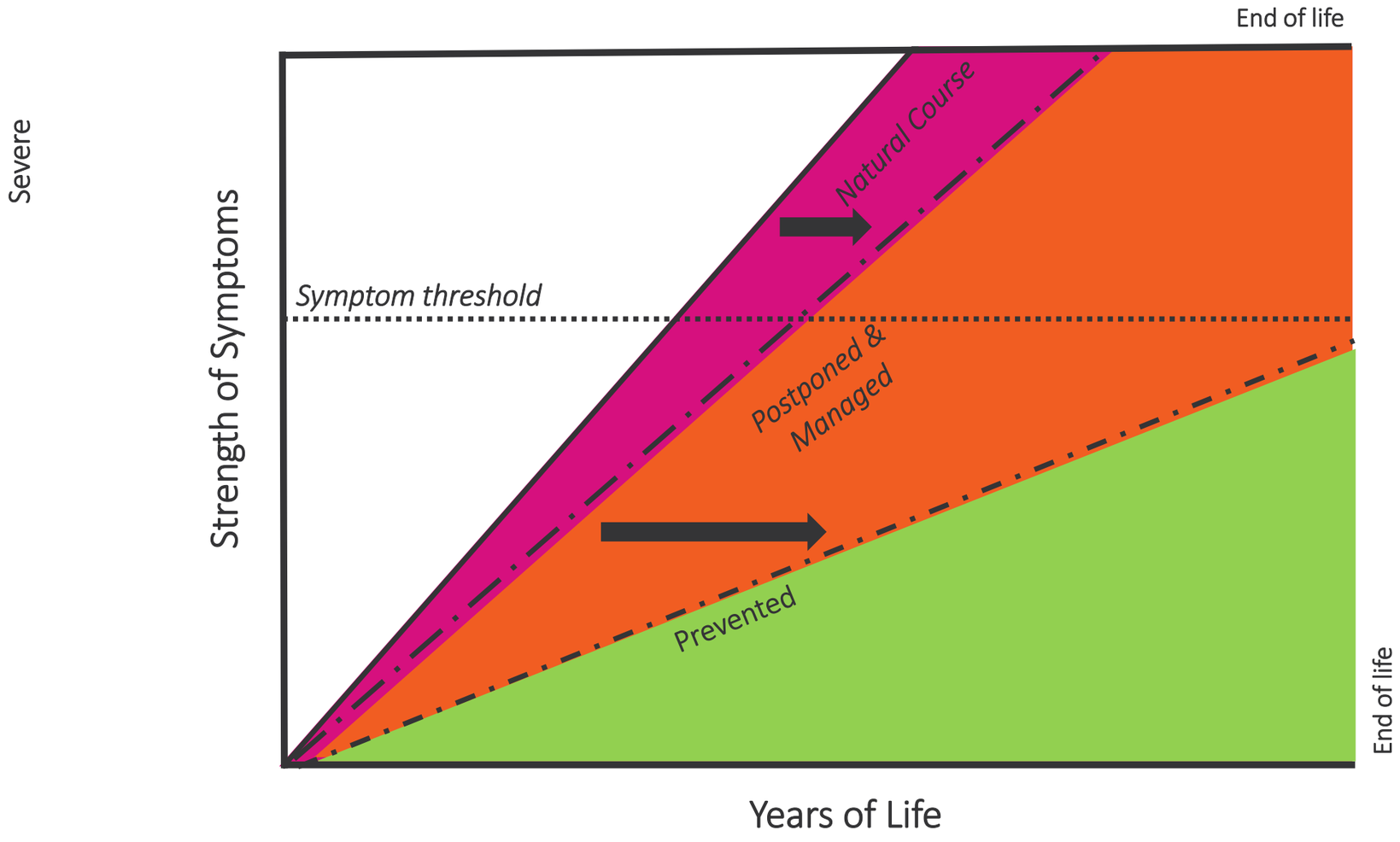
§ THE IMPORTANCE OF MODIFIABLE BEHAVIOR IN MITIGATING RISK

"Rigorous analysis of levels and trends in exposure to leading risk factors and quantification of their effect on human health are important to identify where public health is making progress and in which cases current efforts are inadequate."

The Lancet: Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019
GBD 2019 Risk Factors Collaborators (2020).

CHRONIC CONDITIONS

Lifestyle Impacts



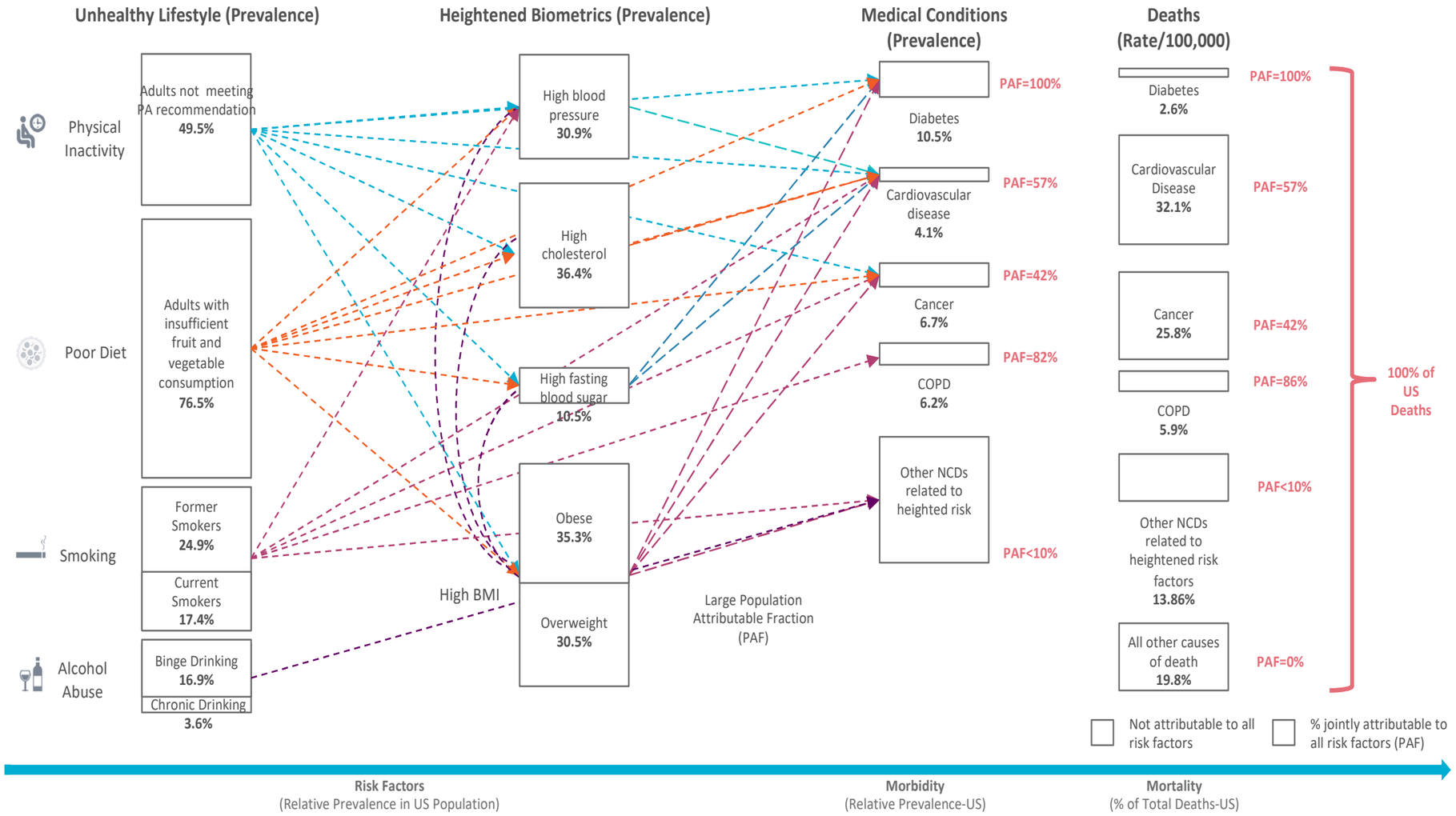
Severe
Symptoms are present from middle age until (early) death

Mild
Onset of symptoms is delayed and/or diligently managed

Sub Clinical Lifestyle Disease
The cause of death is not related to lifestyle, instead diseases of aging

James F. Fries, *The Compression of Morbidity*, The Milbank Memorial Fund Quarterly, Vol.61, No.3: 1983. Access at: https://www.jstor.org/stable/3349864?origin=crossref

The **Causal Relationships** Among Risk Factors and Health Outcomes are **Complex** but Important to Understand for Healthy Aging



Sources: US data: GBD 2016, CDC–BRSFF, various years)

Further reading: www.soa.org/globalassets/assets/files/resources/research-report/2021/healthy-lifestyles-in-retirement.pdf

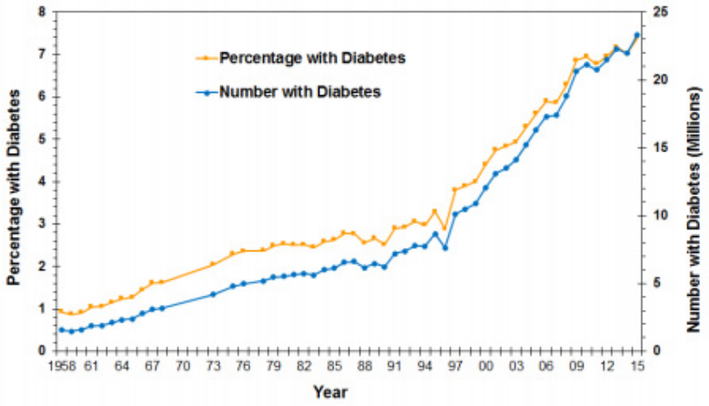
Diabetes Provides an Instructive Example

Diabetes impacts a large **proportion of the population**

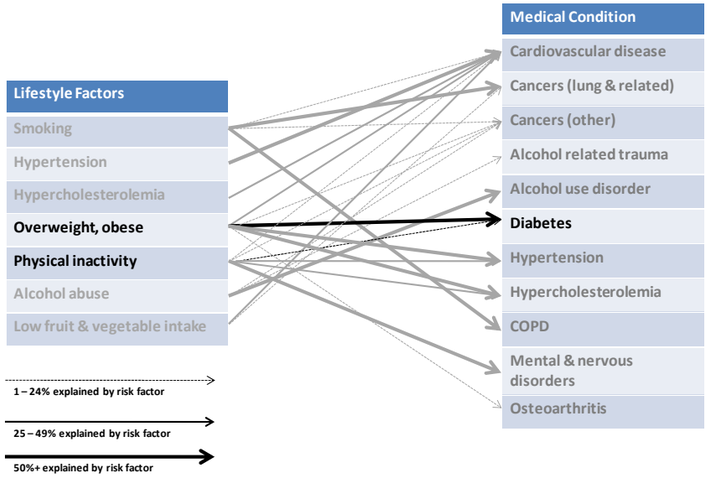
45%
of the U.S. population are either diabetic or pre-diabetic[1]

Prevalence is rapidly **rising**[2]

Number and Percentage of U.S. Population with Diagnosed Diabetes, 1958-2015



There is a direct and strong linkage to **heightened lifestyle risk factors**[3]



1. CDC. National Diabetes Statistics Report, 2020. Accessed from: https://www.cdc.gov/diabetes/data/statistics-report/index.html
2. CDC. Division of Diabetes Translation. United States Diabetes Surveillance System. Accessed from: https://www.cdc.gov/diabetes/data/
3. Modified from: *The Global Burden of Disease and Risk Factors*, Alan D. Lopez, et. al., WHO and Oxford University Press, 2006.

Diabetes Provides an Instructive **Example**

HOW TO RELATE RISK FACTORS AND ILLNESS

Step 1
Determine the causative risk factors and identify relationships among causative risk factors and medical conditions

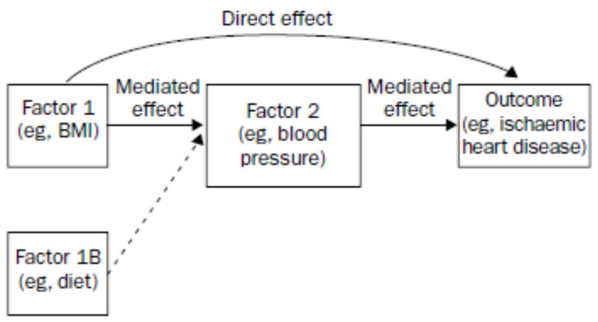
Step 2

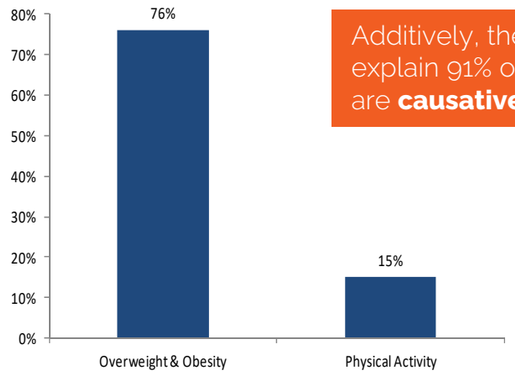
Quantify relationships – by risk factor and condition - between historical heightened risk and current disease incidence

Some risk factor-medical condition links are simple 1-1 relationships, whilst others are complex. These differences are recognized in single and joint population attribution fractions (PAFs).

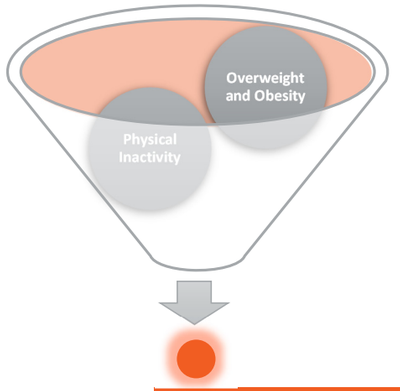
The **Population Attribution Fraction (PAF)** is the percentage by which incidence of the disease can be reduced by getting risk factors to their theoretical minimum levels.[1]

We can optimize the risk factors to their theoretical minimums to quantify the relationships, setting BMI to 21 and physical activity to 150 minutes per week





Additively, these two risks might explain 91% of diabetes, but they are **causatively interrelated**.



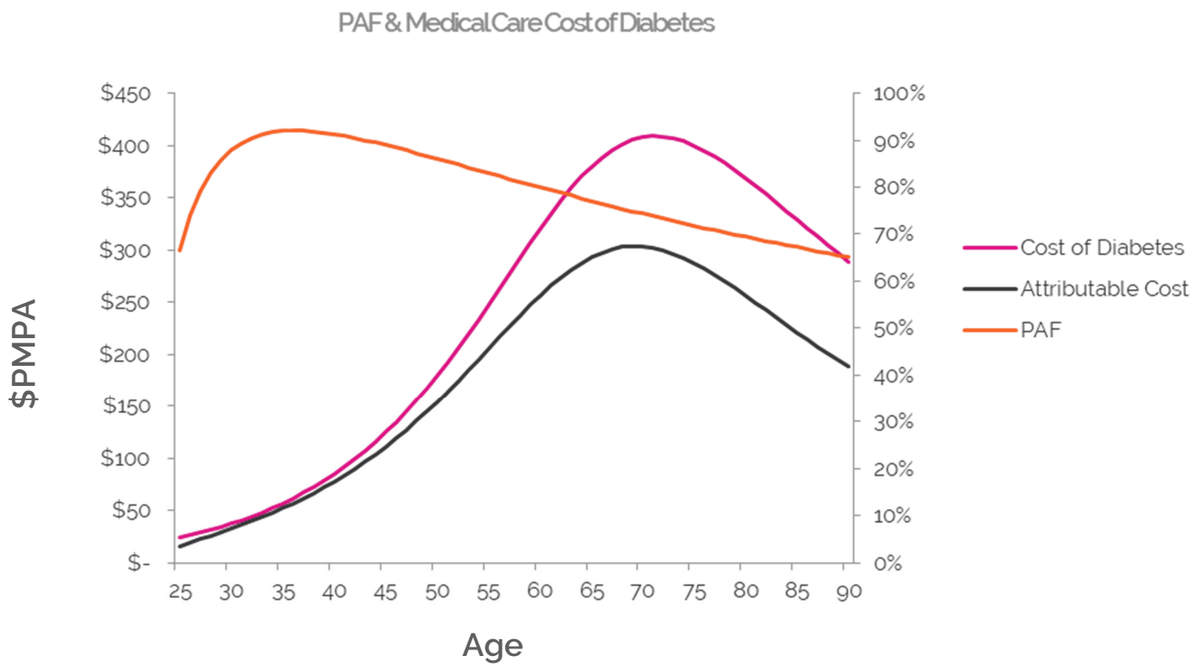
Joint PAF 79% - and not 91% - reduction in prevalence of type 2 diabetes can be achieved by controlling lifestyle risk factors

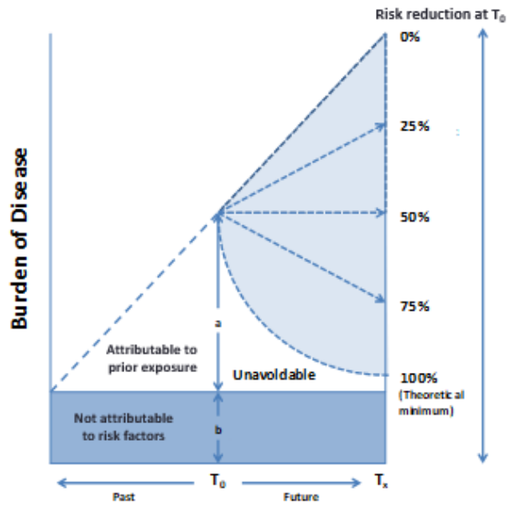
1. Modified from: *The Global Burden of Disease and Risk Factors*, Alan D. Lopez, et. al., WHO and Oxford University Press, 2006.

Linking Health to Medical Costs: A **Concept Primer**

- **Cost of Illness** – medical care costs for specific diseases, excluding complications and co-morbidities
- **Attributable Cost of Illness** – proportion of existing burden of disease related to histories of heightened lifestyle risk factors
- **Risk Factors** – relative relationships between lifestyle risks and disease-specific burden of disease
- **Avoidable Cost of Illness** - proportion of attributable burden that could be eliminated by a transition from current population distributions of risk factors to lower risk distributions
  - **Theoretical Maximum Avoidable COI** assumes reductions in risk factors to their theoretical minimum = Attributable COI
  - **Achievable Avoidable COI** assumes reducing population risk factors, over time, to realistically achievable levels

DIABETES EXAMPLE





Reducing a risk to theoretical minimums will not result in immediate reductions in disease rates and therefore costs to treat those diseases

Chapter 2

§ A FRAMEWORK WITH WHICH TO UNDERSTAND COMPLEXITY

"There is a robust understanding of how specific behavioral, metabolic, and environmental risk factors increase the risk of health burden. However, there is less understanding of how these risks individually and jointly affect health-care spending."

Bolnick, Howard & Bui, Anthony & Bulchis, Anne & Chen, Carina & Chapin, Abigail & Lomsadze, Liya & Mokdad, Ali & Millard, Francois & Dieleman, Joseph. (2020). Health-care spending attributable to modifiable risk factors in the USA: an economic attribution analysis. The Lancet. Public health. 5. e525-e535. 10.1016/S2468-2667(20)30203-6.

The Risk and Outcome **Framework**

- Research conducted by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington (U.S.A.) supports the **Global Burden of Disease (GBD) Risk & Outcomes Framework**
- IHME organized and manages a consortium of more than **7,000 researchers** in more than **156 countries**
- Global Burden Disease (GBD) Studies currently quantify health loss metrics for **286 causes of death**, **369 diseases and injuries**, and **87 risk factors**
- GBD Studies organize cause-specific population mortality and morbidity data for **195 countries** and, for select countries, subnational geographies by medical condition, time, age, and sex
- GBD Comparative Risk Assessment (CRA) is a **comprehensive model of by condition mortality and morbidity attributable to modifiable risk factors by time, age, and sex**
- GBD CRA model aggregates and integrates causal relationships and relative risks from high quality epidemiology and clinical investigations
- Data, methodology, analyses, and visualizations accessible at http://www.healthdata.org

The Science Underpinning the **Linkages** between **Disease** and **Medical Costs**


Global Health Metrics

Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017

Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the Global Burden of Disease Study 2017

Death and **incidence**, **prevalence** and **years lived with disability** (YLD) for 354 health conditions and 282 causes of death in 195 countries


Global Health Metrics

Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017

Heath conditions and **causes of death** by 84 **modifiable** and **causal risk** factors individually and jointly estimated


Research

JAMA | Original Investigation

US Health Care Spending by Payer and Health Condition, 1996-2016

U.S. **health-care spending** by 350 diseases and injuries


Articles

Health-care spending attributable to modifiable risk factors in the USA: an economic attribution analysis

U.S. **health-care spending** for 350 diseases and injuries by 84 modifiable risk factors

The Lancet Global Burden of Disease Special Issue
Research Papers 1 & 2[1]

JAMA
Research Paper 3[2]

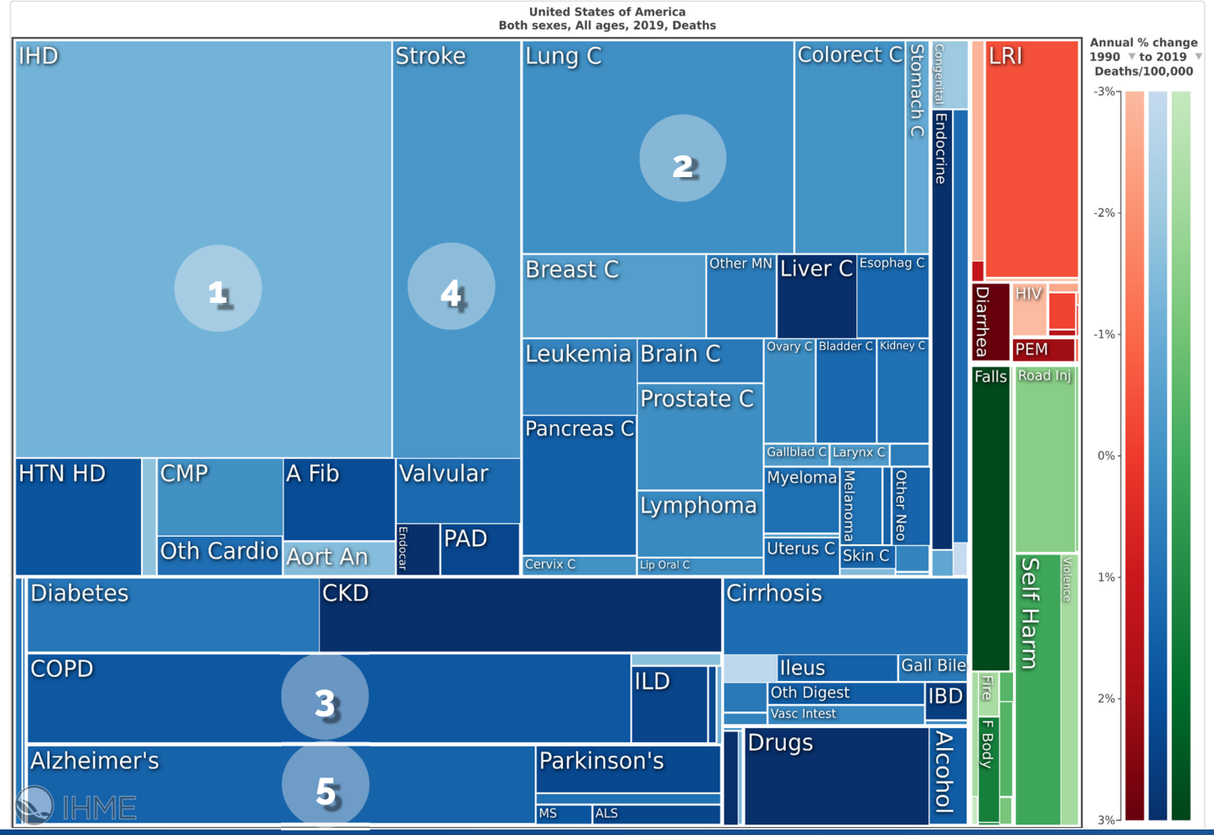
The Lancet Public Health
Research Paper 4[3]

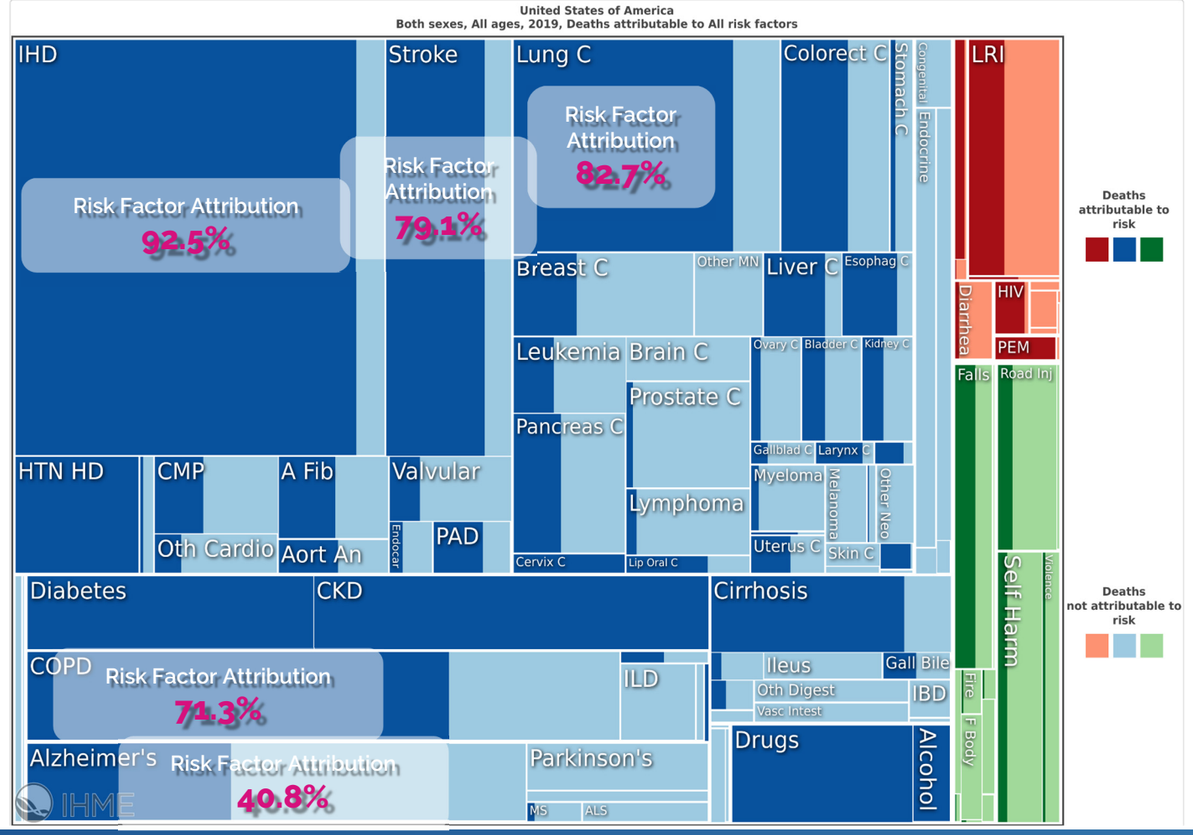
1. https://www.thelancet.com/journals/lancet/issue/vol392no10159/PIIS0140-6736(18)X0048-8
2. https://jamanetwork.com/journals/jama/fullarticle/2762309
3. https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(20)30203-6/fulltext

The **Methodology**

- Mortality, morbidity, and risk factor data gathered from a wide range of national and international sources
- Causal risk factor relationships based on expert panels' review of clinical and epidemiology literature
- GBD population mortality and morbidity estimates for: *deaths*, *years of life lost (YLL)*, *prevalence and incidence of morbidity*, *years lost to disability (YLD)*, and *disability adjusted life years (DALY)*
- Attributable mortality and morbidity estimated using an historical counterfactual model
  - Relative risk for each risk factor assessed against its theoretical minimum risk exposure level (TMREL)
  - Interrelations among risk factor and their effects on medical conditions are jointly estimated using modification factors a competing risk model
    - Causal risk factors are often interrelated. E.g., sum of individual risk factor related to CVD (ischemic heart disease and stroke) are much greater than 100%
- U.S.A. health-care spending by condition aggregated from public and private sources
- U.S.A. health-care spending for each medical condition related to its most statistically significant GBD measure

U.S.A. **Mortality** and the Joint Attribution of Risk Factors





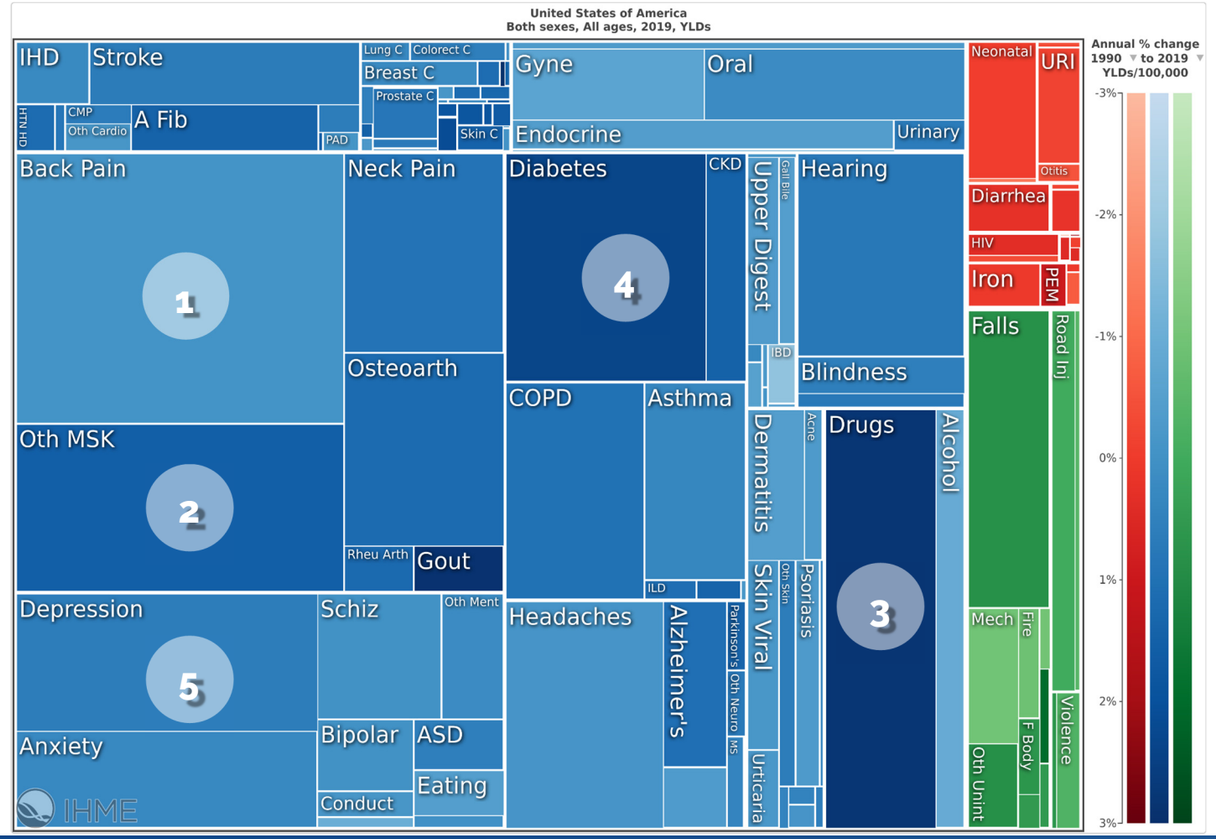
Attributable Modifiable Risk Factors

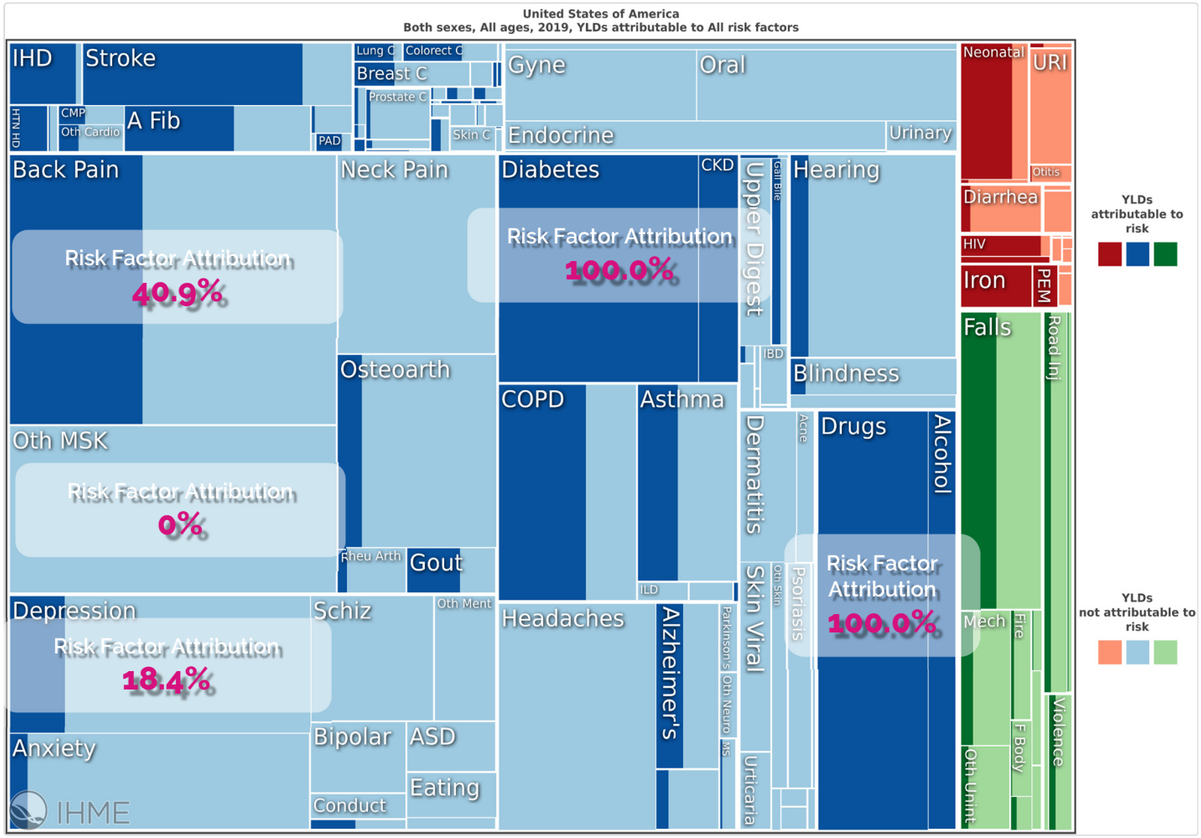
	$f(\ldots)$						
	High SBP	**High LDL Cholesterol**	**High FPG**	**High BMI**	**Tobacco**	**Dietary Risk**	**Occupational Risks**
1. Ischemic Heart Disease	x	x	x	x	x	x	
2. Lung Cancer			x		x		x
3. COPD					x		
4. Stroke	x		x	x	x	x	
5. Alzheimer's			x	x	x		

Aggregate Risk Factor Attributions

NCD	63.8%
Communicable, maternal, neonatal, and nutritional conditions	44.7%
Injuries	28.4%
All Deaths	60.8%

U.S.A. **Morbidity** and the Joint Attribution of Risk Factors





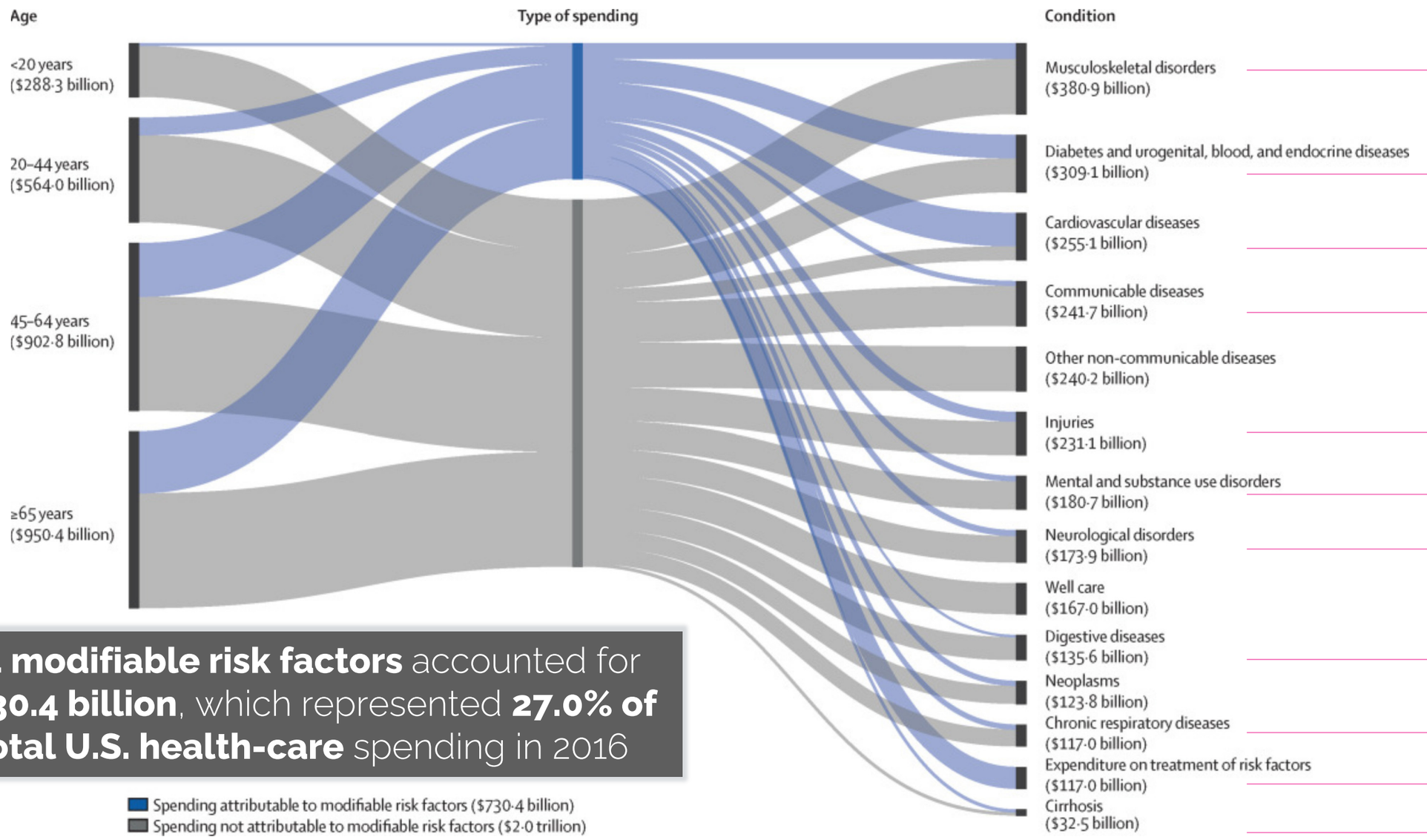
Attributable Modifiable Risk Factors

	$f(\ldots)$								
	High FPG	**High BMI**	**Tobacco**	**Dietary Risk**	**Low Physical Activity**	**Occupational Risks**	**Drug Use**	**Childhood Sexual Abuse and Bullying**	**Intimate Partner Violence**
1.Back Pain		x	x			x			
2. Other Musculoskeletal									
3. Drug Use Disorder			x				x		
4. Diabetes	x	x	x	x	x				
5. Depressive Disorder								x	x

Aggregate Risk Factor Attributions

NCD	32.4%
Communicable, maternal, neonatal, and nutritional conditions	49.5%
Injuries	32.7%
All Deaths	33.02%

U.S.A. **Health-Care Spending** and the Joint Attributable Spending



84 modifiable risk factors accounted for **$730.4 billion**, which represented **27.0% of total U.S. health-care** spending in 2016

Figure 1: **Spending by age, spending attribution, and aggregated condition category, 2016**
Health-care spending is measured in 2016 US dollars.

Risk Factor Attribution

Musculoskeletal disorders	21.9%
Diabetes and urogenital, blood, and endocrine diseases	40.9%
Cardiovascular diseases	70.9%
Communicable diseases	10.7%
Other non-communicable diseases	
Injuries	22.7%
Mental and substance use disorders	21.9%
Neurological disorders	18.3%
Well care	
Digestive diseases	9.4%
Neoplasms	
Chronic respiratory diseases	23.3%
Expenditure on treatment of risk factors	100.0%
Cirrhosis	49.9%

U.S.A. **Health-Care Spending** by **Risk Factor and Condition**

*High **BMI**, high systolic **blood pressure**, high fasting plasma **glucose**, **dietary** risk, and **smoking** are the five highest impact risk factors*

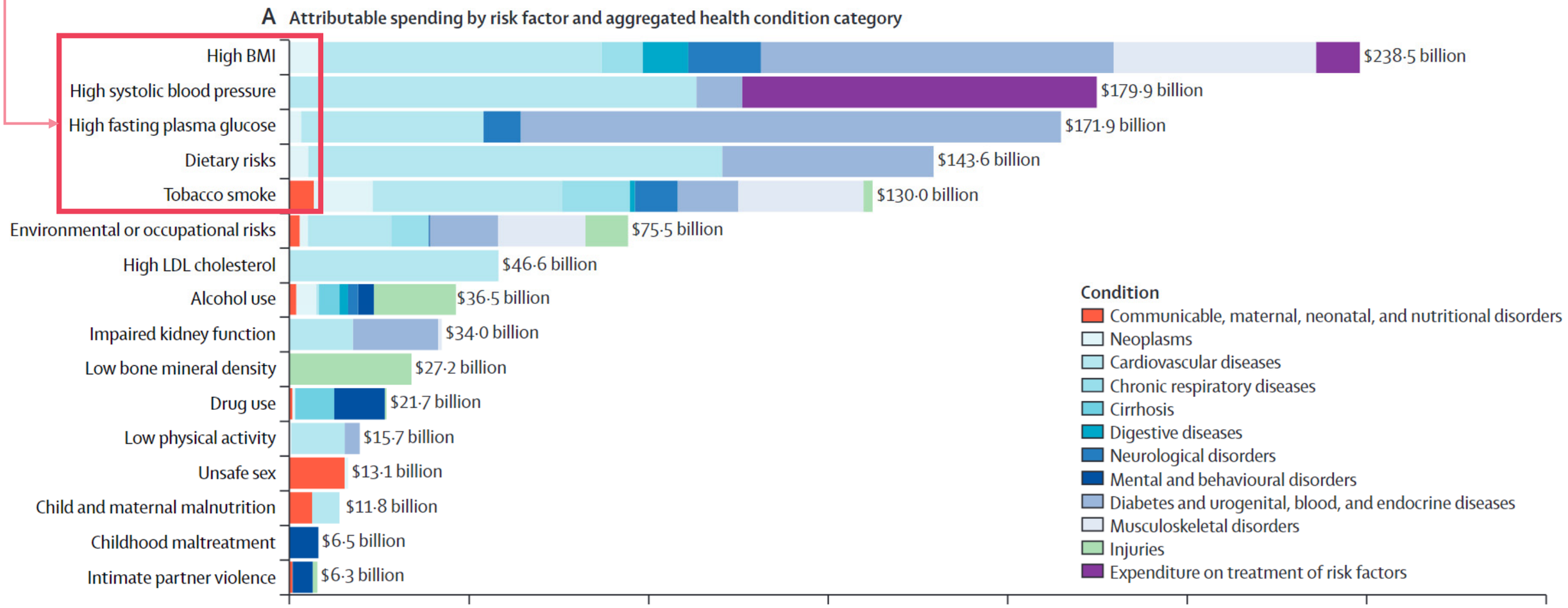
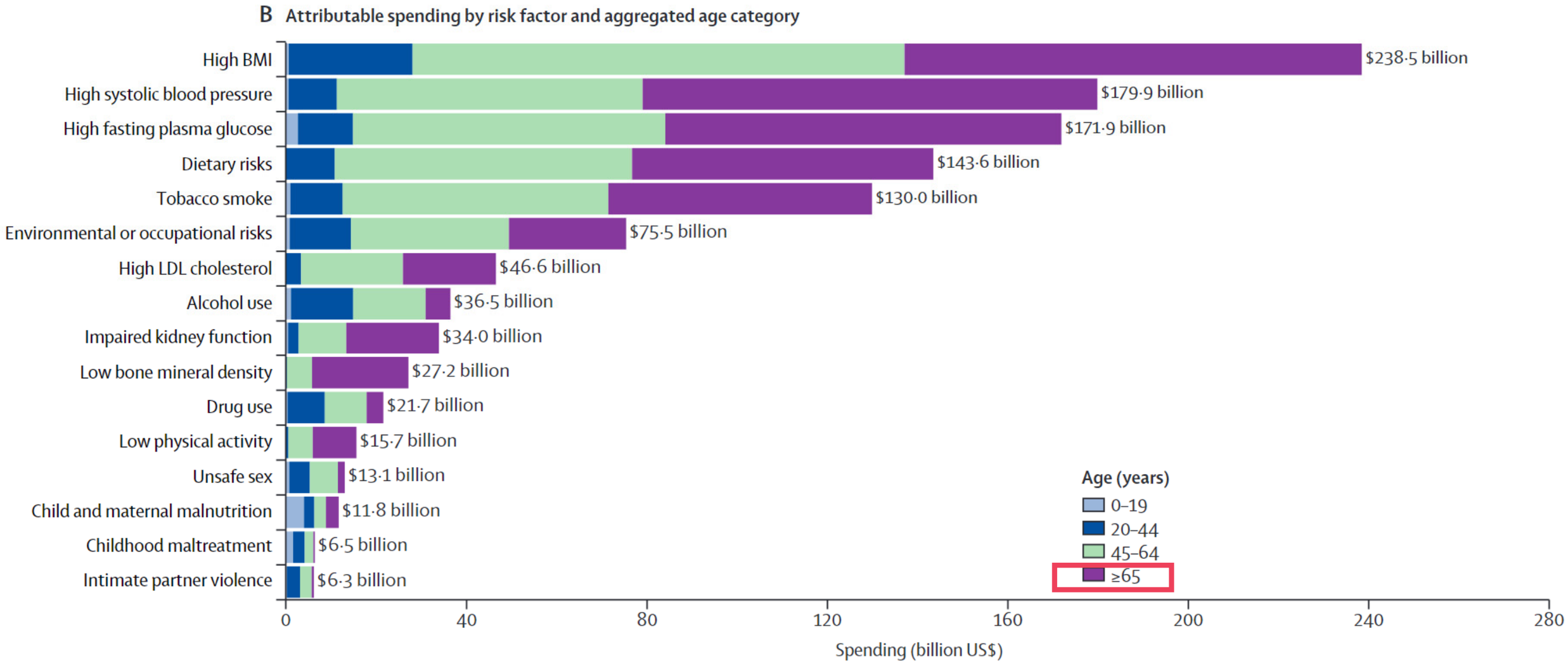


***Figure 2*: Health-care spending attributable to risk factor categories by aggregated health condition (A) and age group (B), 2016**

Health-care spending is measured in 2016 US dollars. Due to risk interaction and mediation, attributable spending by risk category does not sum up to total attributable spending. BMI=body-mass index.

U.S.A. **Health-Care Spending** by **Risk Factor and Condition**

*Those **aged 65+** have the highest impact on health-care spending*



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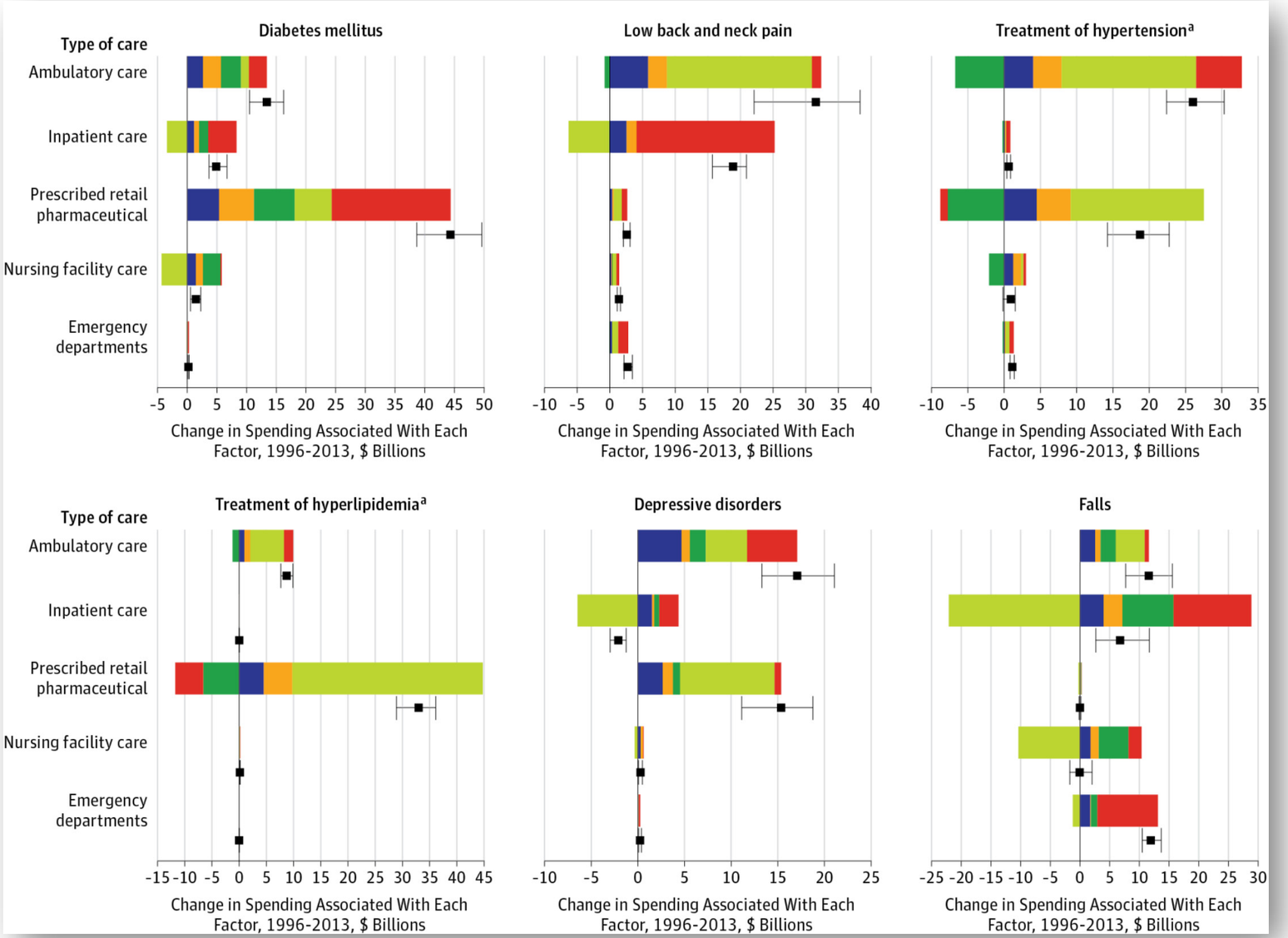
Health-care spending is measured in 2016 US dollars. Due to risk interaction and mediation, attributable spending by risk category does not sum up to total attributable spending. BMI=body-mass index.

The **Drivers** of Health-Care Spending Increases



Population size | Population age | Disease prevalence or incidence | Service utilization | Service price and intensity | Total change

Original Investigation

November 7, 2017

Factors Associated With Increases in US Health Care Spending, 1996-2013

Joseph L. Dieleman, PhD[1]; Ellen Squires, MPH[1]; Anthony L. Bui, MPH[2]; et al

Author Affiliations | Article Information

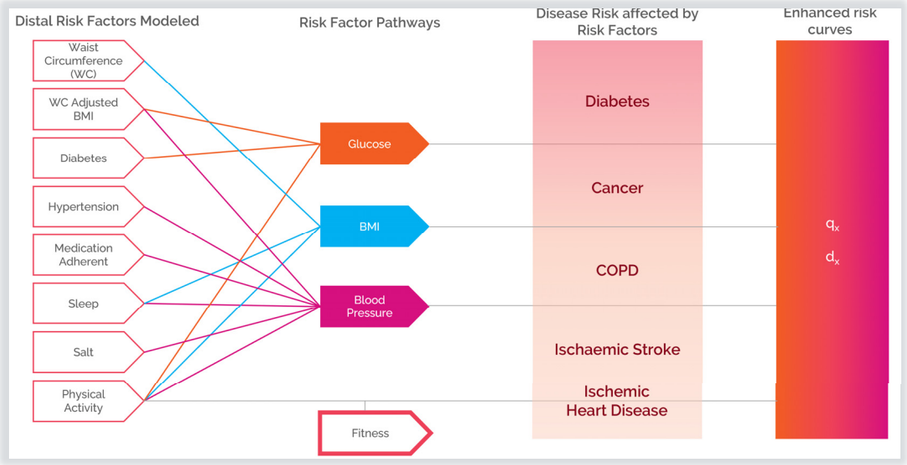
JAMA. 2017;318(17):1668-1678. doi:10.1001/jama.2017.15927

https://jamanetwork.com/journals/jama/fullarticle/2661579

Conclusions

- **Reducing modifiable risk factors has strong potential to significantly reduce health-care spending**
  - U.S.A. health-care spending attributable to 84 modifiable risk factors accounted for 27.0% of total spending in 2016.
  - U.S.A. spending patterns inform comparable attributable spending in other countries
  - While reducing all risk factors to their theoretical minimums is not possible, our findings support the significant value of public and private sector health promotion and prevention initiatives
- Among adults, **five modifiable risk factors account for the most attributable spending, but actuarial modelling of these should consider distal relationships**

1. High BMI
2. High systolic blood pressure
3. High fasting plasma glucose
4. Dietary risks
5. Tobacco smoking



Illustrative example of risk factor pathways; source: Vitality Group International

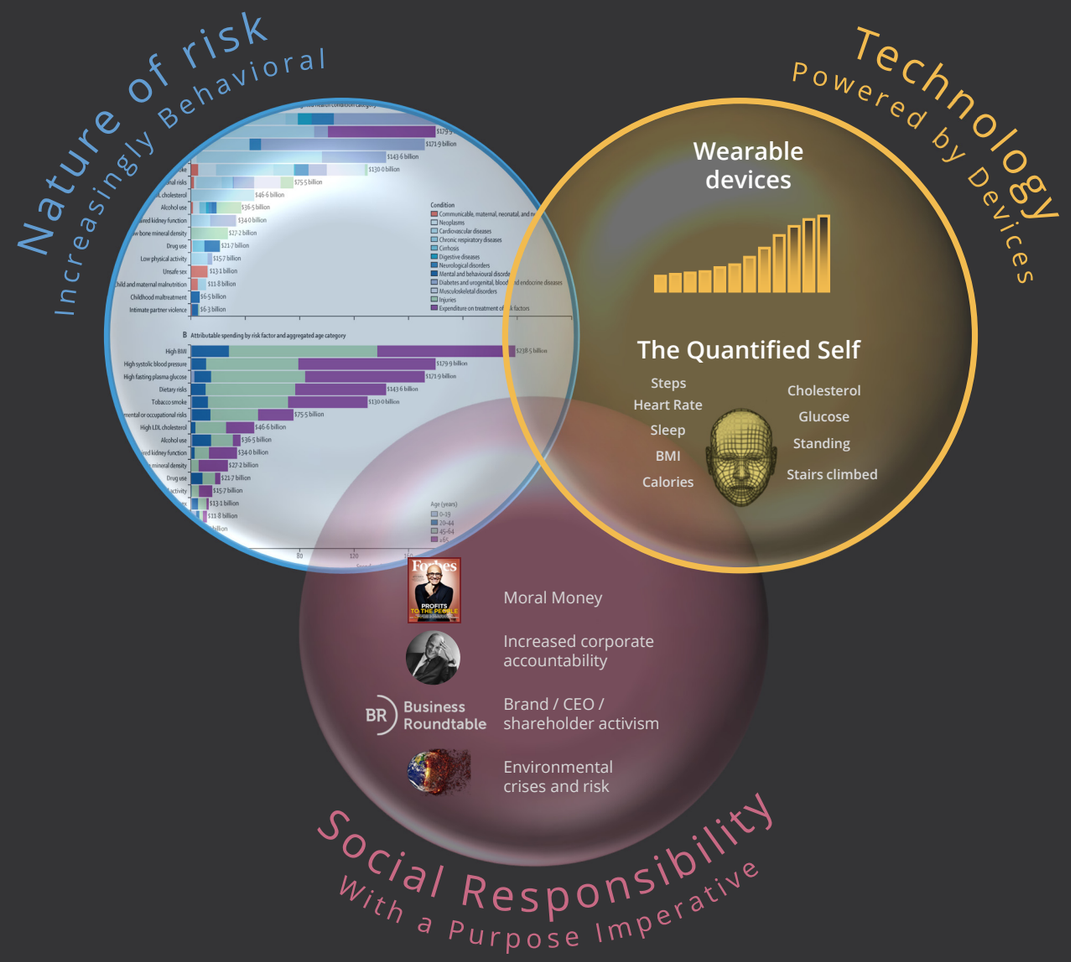
- Findings provide information on **relationships between *causes* and *consequences* that allow insurers and other risk bearers to become active participants in improving the health of their covered lives**

Chapter 3

§ BUSINESS APPLICATIONS

There are new trends shaping the world and insurance has an important role to play at the nexus of risk, technology, and social responsibility

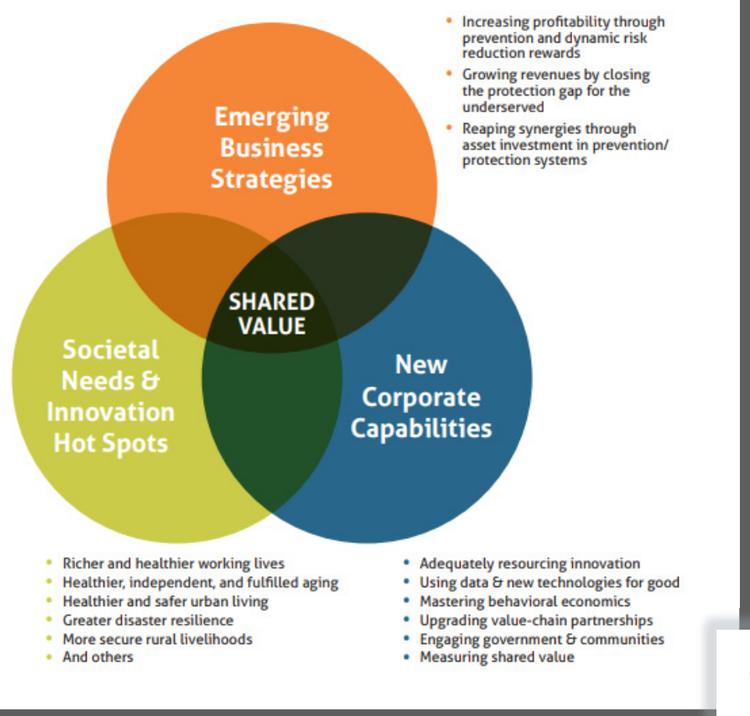
The Nature of **Risk is Increasingly Behavioral** and Can Be **Mitigated**



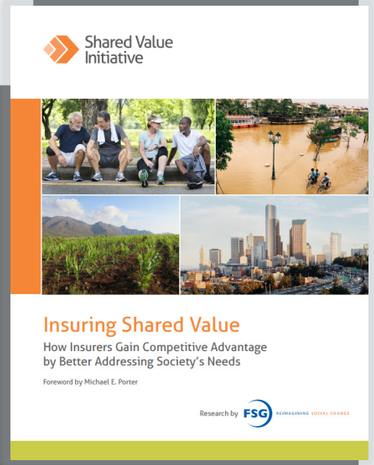
- **Requires a robust understanding of modifiable risk factor that *cause* mortality and morbidity**
- **Wearable devices** and other **enhanced consumer data** increasingly allow risk bearers to **monitor these *causes***
- Which allows risk bearers to **identify** modifiable risks and **incentivize behavior changes** that *cause* disease and death and thereby effecting changes in *consequences* (mortality and morbidity)
- Allows progressive risk bearers to **improve their insured lives mortality and morbidity**

Through Products that **Incent Individuals** and **Create Shared Value**

FIGURE 1: FRAMEWORK TO IDENTIFY SHARED VALUE OPPORTUNITIES



Insurance is the ultimate shared value industry, where social impact is integral to economic success.
Reducing accidents, improving health, and helping organizations better prepare for economic risks all improve the profitability of insurers.



ource: https://www.fsg.org/publications/insuring-shared-value

CASE STUDY: DISCOVERY VITALITY

The Mathematics of Shared-Value Insurance

$$\frac{\text{Value}}{\text{Member}} = \frac{\text{Incentive}}{\text{Member}} \times \frac{\Delta\ \text{Behaviour}}{\text{Incentive}} \times \frac{\text{Risk Improvement}}{\Delta\ \text{Behaviour}} \times \frac{\text{Value}}{\text{Risk Improvement}}$$

The Virtuous Cycle Created by Shared-Value Insurance

Vitality®

Limitations of the Study

- GBD estimates are modeled based on aggregating studies across different populations
  - Few of the populations are insured lives
- GBD risk factor attributions are retrospective counter-factual estimates
  - Significances among distal and proximate risk factors change significantly when applied to a retrospective versus a prospect attribution model
  - Studies do not incorporate genetic links
- U.S.A. health-care spending differs from that of other countries
  - U.S. spending is much higher
  - Distribution of spending by medical conditions will differ
- Population attribution fractions directly linking risk factors and health-care spending do not exist
  - These links are estimated in GBD using a statistical model
- Attributable spending estimates are based on reducing risk factors to their theoretical minimums (TMREL levels)
  - Health-care spending reductions of these magnitudes cannot be achieved