

Joint SAS-IAAHS Health Conference

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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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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.

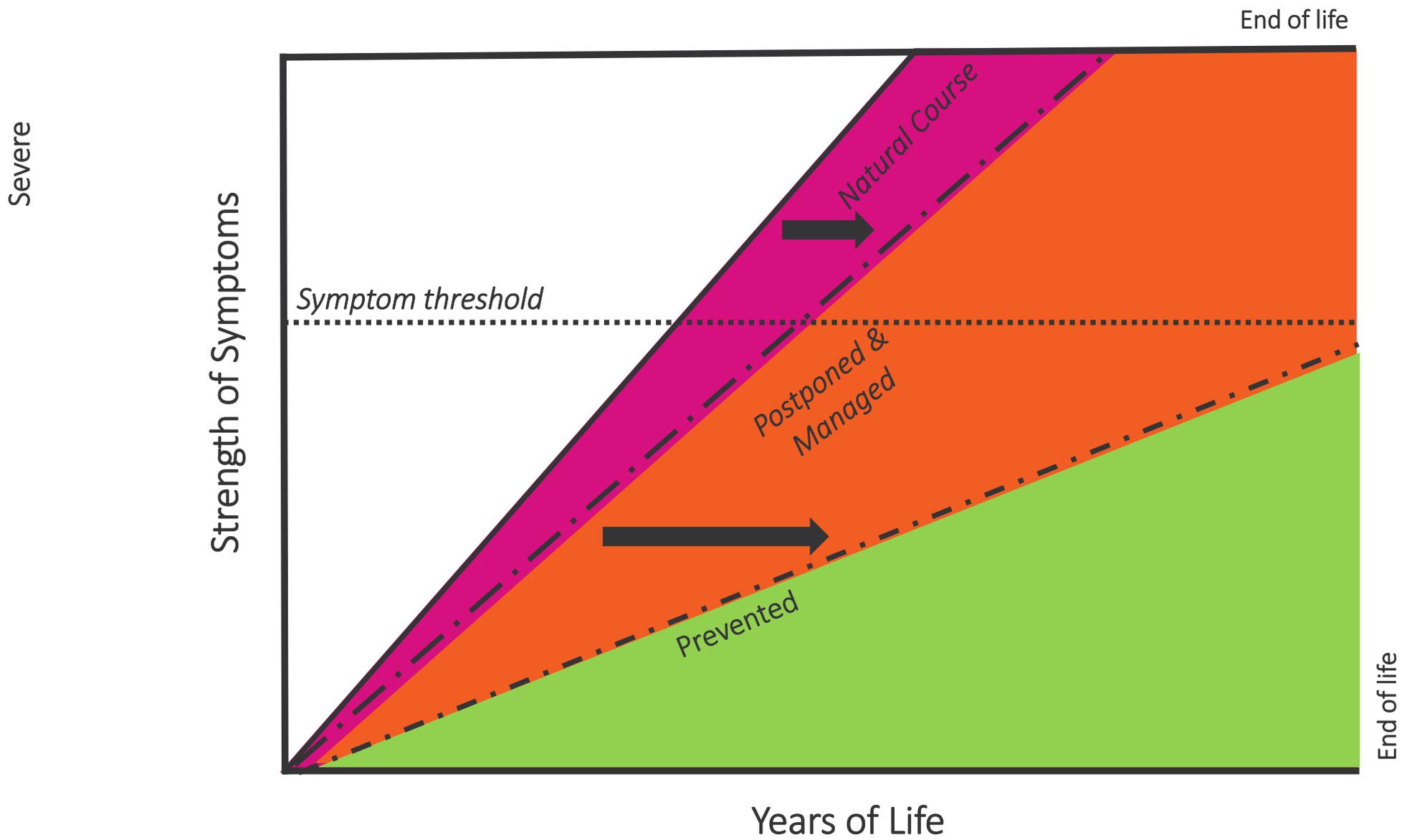


Chapter 1

§ 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.”

Lifestyle Impacts



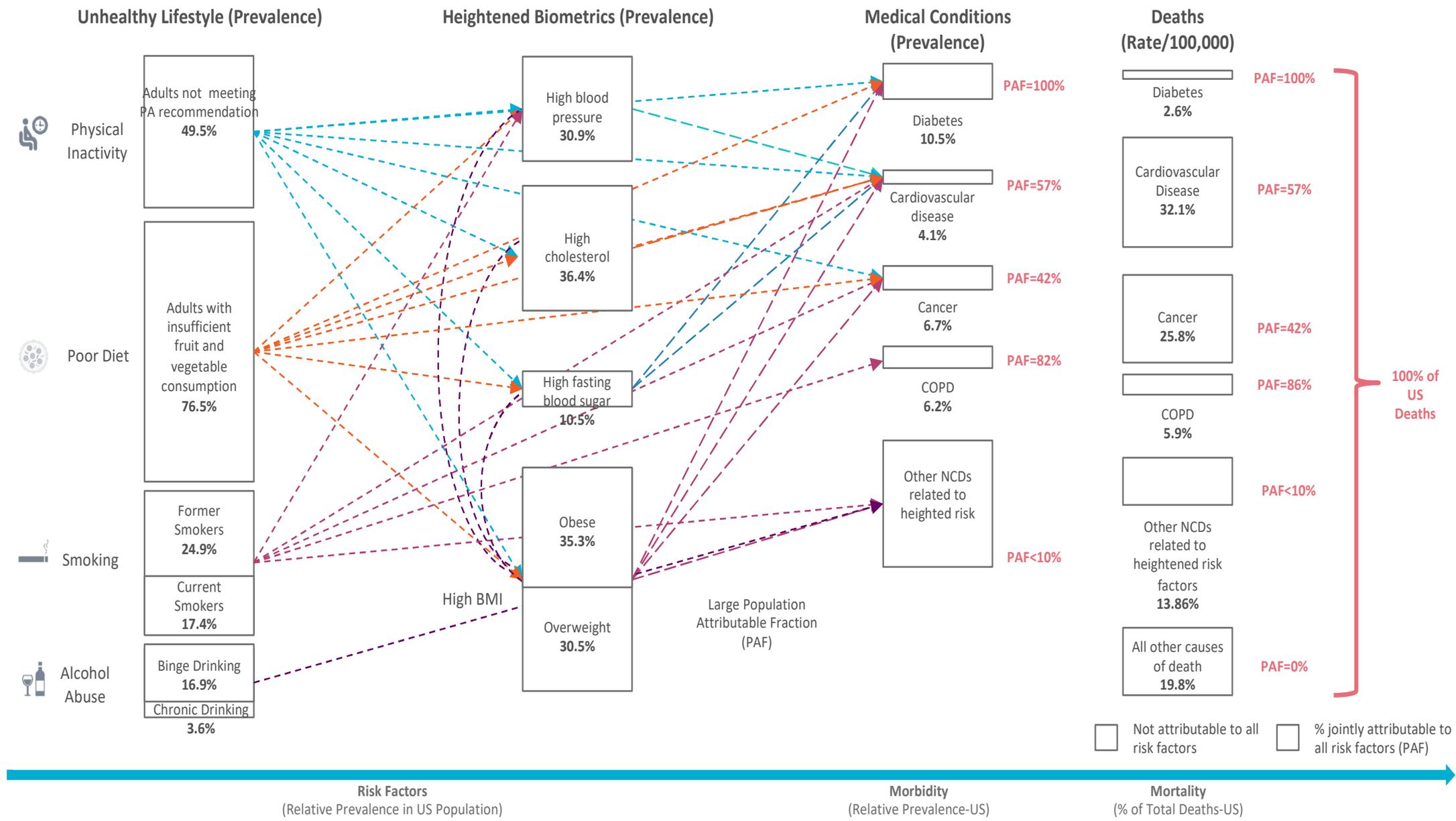
- Severe**
Symptoms are present from middle age until (early) death
- Mild**
Onset of symptoms is delayed and/or diligently managed
- Sub Clinical Lifestyle Disease**
The cause of death is not related to lifestyle, instead diseases of aging

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

Aging and Retirement

Maximizing Health Span: A Literature Review on the Impact of a Healthy Lifestyle on Retirement

September 2021



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

Diabetes Provides an Instructive Example

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

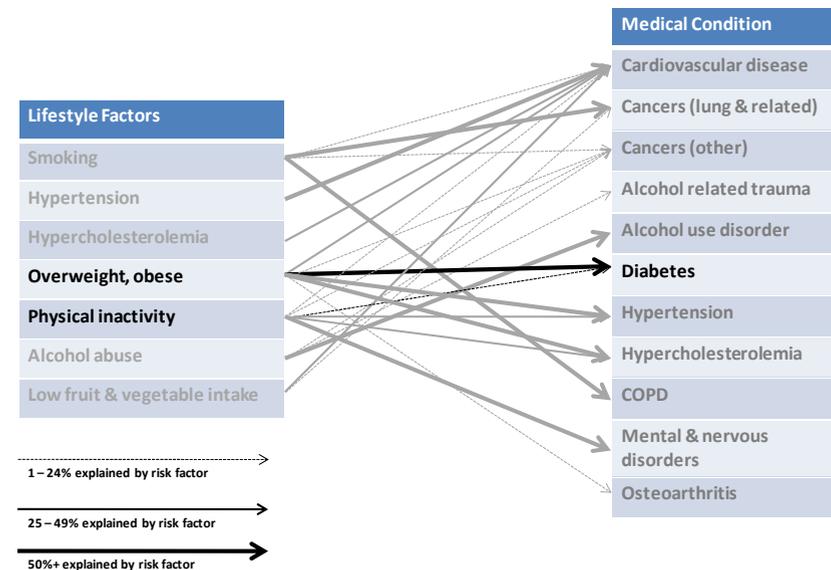
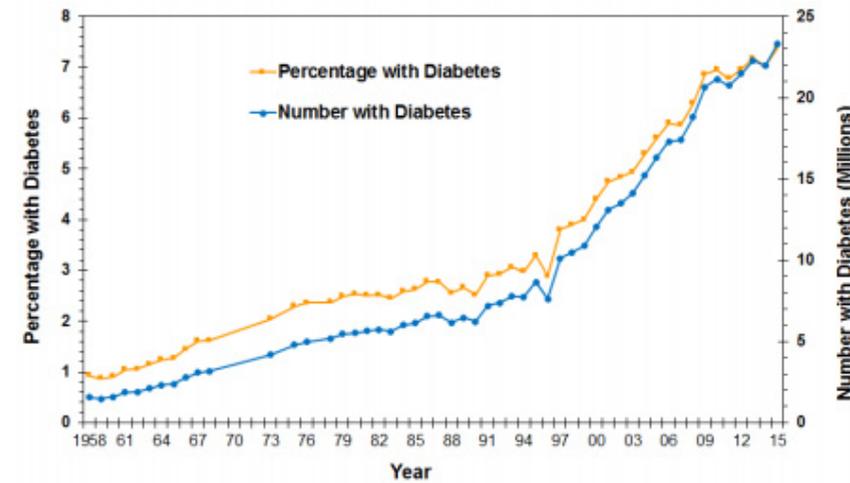
Prevalence is rapidly **rising**²

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

45%

of the U.S. population are either diabetic or pre-diabetic¹

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



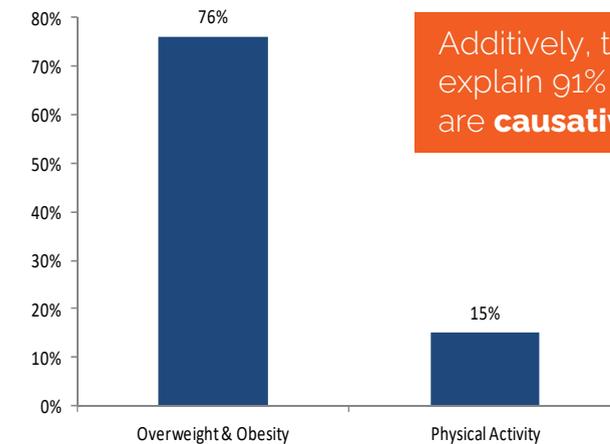
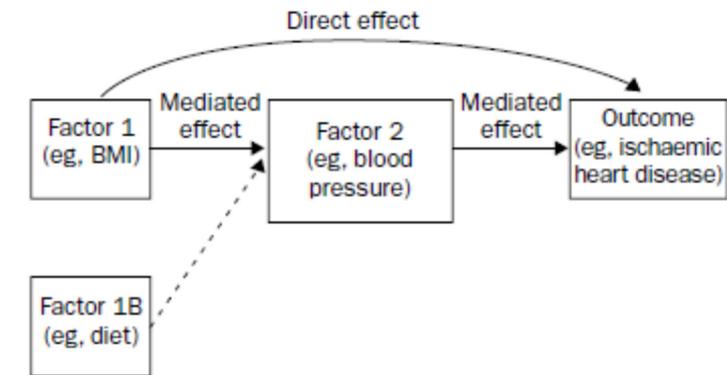
1. CDC. National Diabetes Statistics Report, 2020. Accessed from: <https://www.cdc.gov/diabetes/data/statistics-report/index.html>
 2. CDC. Division of Diabetes Translation, United States Diabetes Surveillance System. Accessed from: <https://www.cdc.gov/diabetes/data/>
 3. Modified from: *The Global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

Diabetes Provides an Instructive **Example**

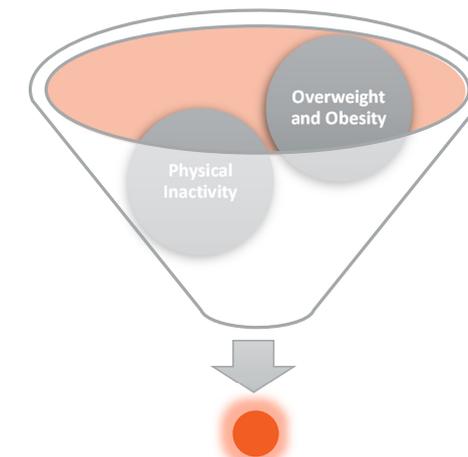
Some risk factor-medical condition links are simple 1-1 relationships, whilst others are complex. These differences are recognized in single and joint population attribution fractions (PAFs).

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

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

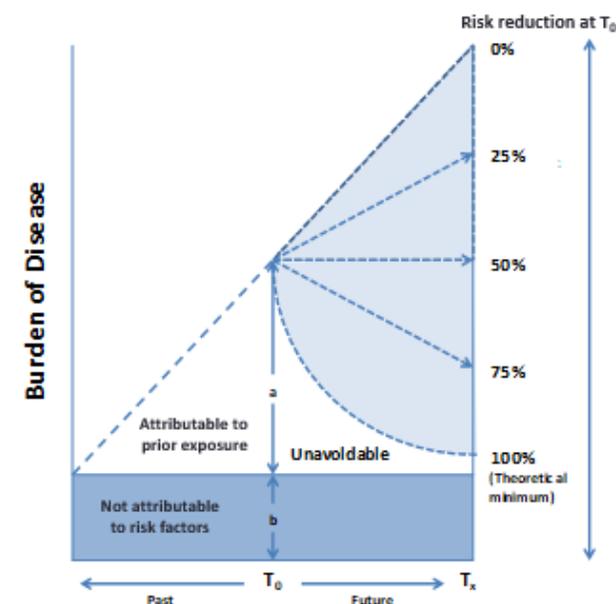
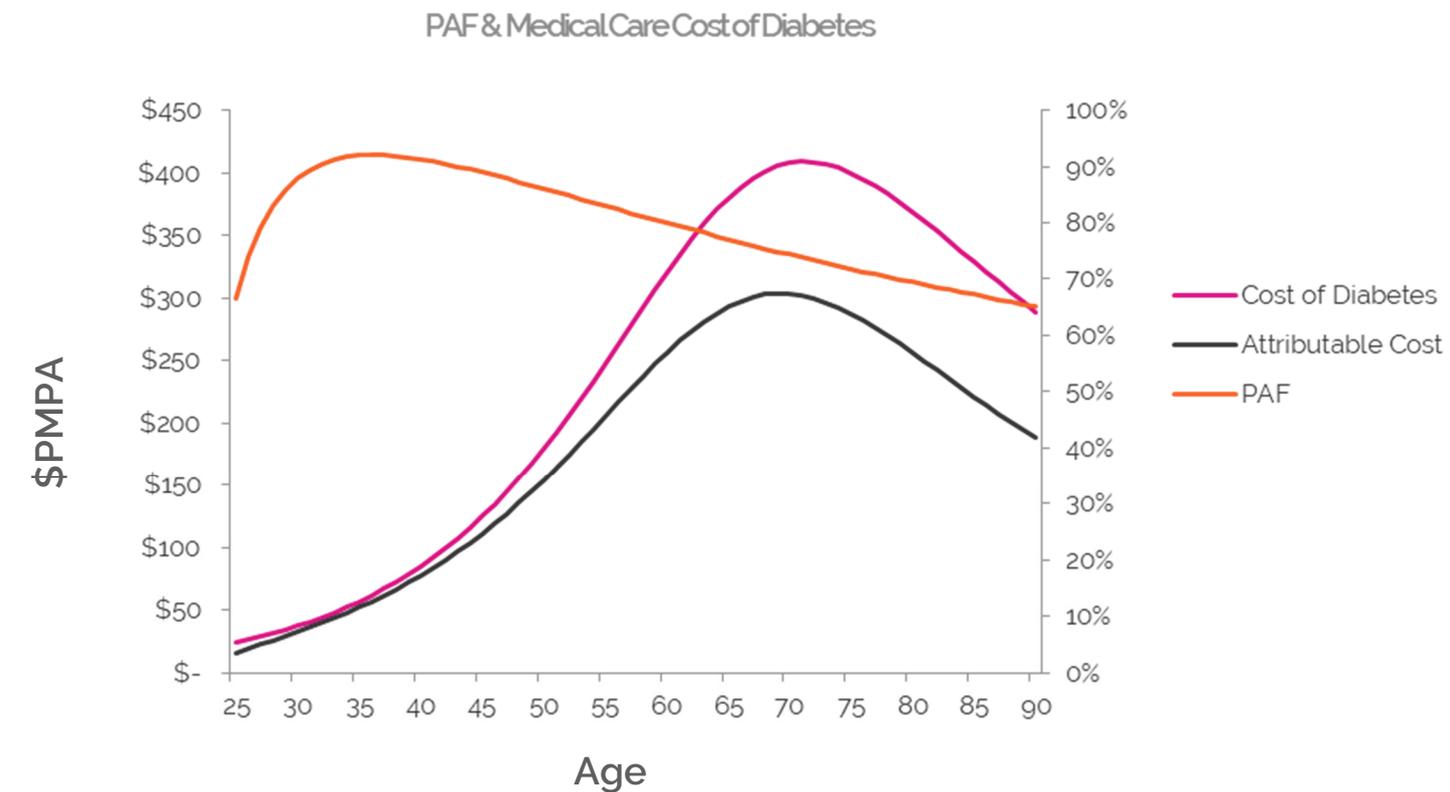
Quantify relationships – by risk factor and condition – between historical heightened risk and current disease incidence

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

THE LANCET Public Health

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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.”

Editorial

Public health must be a priority in the 2020 US election
See page e512

Comment

The cost of preventable disease in the USA
See page e513

Comment

Unemployment, COVID-19, and child health in the USA
See page e521



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

*GBD 2017 Disease and Injuries Incidence and Prevalence Collaborators**

Summary
Background The Global Burden of Diseases, Injuries, and Risk Factors Study 2017 (GBD 2017) includes a comprehensive assessment of incidence, prevalence, and years lived with disability (YLDs) for 354 causes in 195 countries and territories from 1990 to 2017. Previous GBD studies have shown how the decline of mortality rates from 1990 to 2016 has led to a non-fatal burden of disease population experiences in ages, and sexes. Ongoing analytical strategies, and I

Methods We estimated the and extensive body of the records, and health insurance using a total of 48 781 data sources, and they were the (province of China) and St estimation, ensuring our condition. YLDs were each annually calculate a summary development calculated differences between the Guidelines for At

Findings Globally, for five disorders, and haemoglobin age-standardised tuberculosis indicators in 1 deficiency were the health depressive disorders were decreased by 3.9% (95% CI by 7.2% (6.8–4.4) males and 6.5% (5.4–7.7) for female prevalence estimates for 1 included substance use of 10 000 in females), zero violence (1243–3630

Interpretation Global all-c three decades. However, numbers of people who h since 1990, whereas obser across the globe appear improvements in premat expensive diseases, yet als

Funding Bill & Melinda G

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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

*GBD 2017 Risk Factor Collaborators**

Summary
Background The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2017 comparative risk assessment (CRA) is a comprehensive approach to risk factor quantification that offers a useful tool for synthesizing evidence on risks and risk–outcome associations. With each annual GBD study, we update the GBD CRA to incorporate improved methods, new risks and risk–outcome pairs, and new data on risk exposure levels and risk–outcome associations.

Methods We used the CRA framework developed for previous iterations of GBD to estimate levels and trends in exposure, attributable deaths, and attributable disability-adjusted life-years (DALYs), by age group, sex, year, and location for 84 behavioural, environmental and occupational, and metabolic risks or groups of risks from 1990 to 2017. This study included 476 risk–outcome pairs that met the GBD study criteria for combining or probable evidence of causation. We extracted relative risk and exposure estimates from 46 749 randomised controlled trials, cohort studies, household surveys, census data, satellite data, and other sources. We used statistical models to pool data, adjust for confounding, and estimate risk–outcome pairs. Using the counterfactual scenario of theoretical minimum risk exposure level (TMREL), we estimated the portion of deaths and DALYs that could be attributed to a given risk. We explored the relationship between development and risk exposure by modelling the relationship between the Socio-demographic Index (SDI) and risk-weighted exposure prevalence and estimated expected levels of exposure and risk-attributable burden by SDI. Finally, we explored temporal changes in risk-attributable DALYs by decomposing those changes into six main component drivers of change as follows: (1) population growth; (2) changes in population age structures; (3) changes in exposure to environmental and occupational risks; (4) changes in exposure to behavioural risks; (5) changes in exposure to metabolic risks; and (6) changes due to all other factors, approximated as the risk-deleted death and DALY rates, where the risk-deleted rate is the rate that would be observed had we reduced the exposure levels to the TMREL for all risk factors included in GBD 2017.

Findings In 2017, 34.1 million (95% uncertainty interval [UI] 33.3–35.0) deaths and 1.21 billion (1.14–1.28) DALYs were attributable to GBD risk factors. Globally, 61.9% (59.6–64.2) of deaths and 48.3% (46.3–50.2) of DALYs were attributed to the GBD 2017 risk factors. When ranked by risk-attributable DALYs, high systolic blood pressure (SBP) was the leading risk factor, accounting for 10.4 million (9.39–11.5) deaths and 218 million (198–237) DALYs, followed by smoking (7.10 million [6.83–7.37] deaths and 181 million [173–193] DALYs), high fasting plasma glucose (6.53 million [5.23–8.23] deaths and 171 million [144–201] DALYs), high body-mass index (BMI; 4.72 million [2.99–6.70] deaths and 148 million [98.6–202] DALYs), and short gestation for birthweight (1.43 million [1.36–1.51] deaths and 139 million [131–147] DALYs). In total, risk-attributable DALYs declined by 4.9% (3.1–6.5) between 2007 and 2017. In the absence of demographic changes (ie, population growth and ageing), changes in risk exposure and risk-deleted DALYs would have led to a 23.5% decline in DALYs during that period. Conversely, in the absence of changes in risk exposure and risk-deleted DALYs, demographic changes would have led to an 18.6% increase in DALYs during that period. The ratios of observed risk exposure levels to exposure levels expected based on SDI (O/E ratios) increased globally for unsafe drinking-water and household air pollution between 1990 and 2017. This results suggest that development is occurring more rapidly than are changes in the underlying risk structure in a population. Conversely, nearly universal declines in O/E ratios for smoking and alcohol use indicate that, for a given SDI, exposure to these risks is declining. In 2017, the leading level 4 risk factor for age-standardised DALY rates was high SBP in four super-regions: central Europe, eastern Europe, and central Asia; north Africa and middle East; south Asia; and southeast Asia, east Asia, and Oceania. The leading risk factor in the high-income super-region was smoking. In Latin America and Caribbean was high BMI, and in sub-Saharan Africa was unsafe sex. O/E ratios for unsafe sex in sub-Saharan Africa were notably high, and those for alcohol use in north Africa and the Middle East were notably low.

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Health 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

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IMPORTANCE US health care spending has continued to increase and now accounts for 18% of the US economy, although little is known about how spending on each health condition varies by payer, and how these amounts have changed over time.

OBJECTIVE To estimate US spending on health care according to 3 types of payers (public insurance [including Medicare, Medicaid, and other government programs], private insurance, or out-of-pocket payments) and by health condition, age group, sex, and type of care for 1996 through 2016.

DESIGN AND SETTING Government budgets, insurance claims, facility records, household surveys, and official US records from 1996 through 2016 were collected to estimate spending for 154 health conditions. Spending growth rates (standardized by population size and age group) were calculated for each type of payer and health condition.

EXPOSURES Ambulatory care, inpatient care, nursing care facility stay, emergency department care, dental care, and purchase of prescribed pharmaceuticals in a retail setting.

MAIN RESULTS AND MESSAGES National spending estimates stratified by health condition, age group, sex, type of care, and type of payer and modeled for each year from 1996 through 2016.

RESULTS Total health care spending increased from an estimated \$1.4 trillion in 1996 (13.3% of gross domestic product [GDP], \$2529 per person) to an estimated \$3.1 trillion in 2016 (17.9% of GDP, \$6555 per person). 85.2% of that spending was included in this study. In 2016, an estimated 48.0% (95% CI, 48.0%–48.0%) of health care spending was paid by private insurance, 42.6% (95% CI, 42.5%–42.6%) by public insurance, and 9.4% (95% CI, 9.4%–9.4%) by out-of-pocket payments. In 2016, among the 154 conditions, low back and neck pain had the highest amount of health care spending with an estimated \$134.5 billion (95% CI, \$122.4–\$146.9 billion) in spending, of which 57.2% (95% CI, 52.2%–61.2%) was paid by private insurance, 33.7% (95% CI, 30.0%–38.4%) by public insurance, and 9.2% (95% CI, 8.3%–10.4%) by out-of-pocket payments. Other musculoskeletal disorders accounted for the second highest amount of health care spending (estimated at \$29.8 billion [95% CI, \$16.3–\$44.7 billion]) and most had private insurance (56.4% [95% CI, 52.6%–59.3%]). Diabetes accounted for the third highest amount of the health care spending (estimated at \$11.2 billion [95% CI, \$10.5–\$11.9 billion]) and most had public insurance (49.8% [95% CI, 44.4%–56.0%]). Other conditions estimated to have substantial health care spending in 2016 were ischemic heart disease (\$80.3 billion [95% CI, \$81.1–\$85.5 billion]), falls (\$87.4 billion [95% CI, \$75.0–\$100.1 billion]), urinary diseases (\$86.0 billion [95% CI, \$76.3–\$95.9 billion]), skin and subcutaneous diseases (\$85.0 billion [95% CI, \$80.5–\$90.2 billion]), osteoarthritis (\$80.0 billion [95% CI, \$72.2–\$86.1 billion]), dementias (\$79.2 billion [95% CI, \$67.6–\$93.0 billion]), and hypertension (\$79.0 billion [95% CI, \$72.6–\$86.2 billion]). The conditions with the highest spending varied by type of payer, age, sex, type of care, and year. After adjusting for changes in inflation, population size, and age groups, public insurance spending was estimated to have increased at an annualized rate of 2.9% (95% CI, 2.9%–2.9%), private insurance, 2.6% (95% CI, 2.6%–2.6%), and out-of-pocket payments, 1.9% (95% CI, 1.9%–1.9%).

CONCLUSIONS AND RELEVANCE Estimates of US spending on health care showed substantial increases from 1996 through 2016, with the highest increases in population-adjusted spending by private insurance. Although spending on low back and neck pain, other musculoskeletal disorders, and diabetes accounted for the highest amounts of spending, the payers and the rates of change in annual spending growth rates varied considerably.

Author Affiliations Author affiliations are listed at the end of this article.

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

JAMA Research Paper 3²

Articles

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

Hossein Bahkhi, Anthony J. Bai, Anwar Bahkhi, Carina Chen, Abigail Chapin, Lyle J. Comstock, Ali H. Mokdad, Francois Millard, Joseph L. Delleman

Summary
Background There is a robust understanding of how specific behavioural, 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. The objective of this study was to quantify health-care spending attributable to modifiable risk factors in the USA for 2016.

Methods We extracted estimates of US health-care spending by condition, age, and sex from the Institute for Health Metrics and Evaluation's Disease Expenditure Study 2016 and merged these estimates with population attributable fraction estimates for 84 modifiable risk factors from the Global Burden of Diseases, Injuries, and Risk Factors Study 2017 to produce estimates of spending by condition attributable to these risk factors. Because not all spending can be linked to health burden, we adjusted attributable spending estimates downward, proportional to the association between health burden and health-care spending across time and age for each aggregate health condition. We propagated underlying uncertainty from the original data sources by randomly pairing the draws from the two studies and completing our analysis 1000 times independently.

Findings In 2016, US health-care spending attributable to modifiable risk factors was US\$730.4 billion (95% uncertainty interval [UI] 694.6–768.5), corresponding to 27.4% (95% UI 25.7–28.4) of total health-care spending. Attributable spending was largely due to five risk factors: high body-mass index (\$238.4 billion, 178.2–291.6), high systolic blood pressure (\$179.9 billion, 164.5–196.0), high fasting plasma glucose (\$171.9 billion, 154.8–191.9), dietary risks (\$143.6 billion, 130.3–154.1), and tobacco smoke (\$130.4 billion, 116.8–143.5). Spending attributable to risk factor varied by age and sex, with the fraction of attributable spending largest for those aged 65 years and older (45.5%, 44.2–46.8).

Interpretation This study shows high spending on health care attributable to modifiable risk factors and highlights the need for preventing and controlling risk exposure. These attributable spending estimates can contribute to informed development and implementation of programmes to reduce risk exposure, their health burden, and health-care costs.

Funding Vitality Institute.

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Introduction
Evidence connecting exposure to risk factors and adverse health outcomes has long been used to support the development of public policy and public health promotion and prevention programmes. The US Centers for Disease Control and Prevention has recognized public health programmes that reduced deaths from coronary heart disease and stroke and prevented deaths from smoking as two of the greatest public health achievements of the 20th century, both championed by robust evidence connecting these risks to reductions in healthy life expectancy.¹ Recently, the private sector in some countries, including employers, health insurance companies, and health promotion companies, has been developing programmes to improve individual health and control health-care spending.^{2–7} Although there is a large volume of epidemiology research exploring the causal routes connecting a wide range of behavioural, metabolic, and environmental risk factors and health outcomes, there has been much less research assessing the role that risk factors have on health-care spending. Moreover, studies to date have generally focused on a single risk factor or disease. To our knowledge, no study links a comprehensive set of modifiable risk factors to health-care spending by condition.

To address this research gap, we estimated US health-care spending attributable to 84 modifiable risk factors in 2016, with the latest data available. We included behavioural risks, such as tobacco use and dietary risks; metabolic risks, such as high body-mass index (BMI) and high blood pressure; and environmental risks, such as air pollution and occupational carcinogens. Knowledge of health-care spending attributable to modifiable risk factors can inform choices and priorities for the design of public and private health promotion and prevention programmes, both in the USA and elsewhere.

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

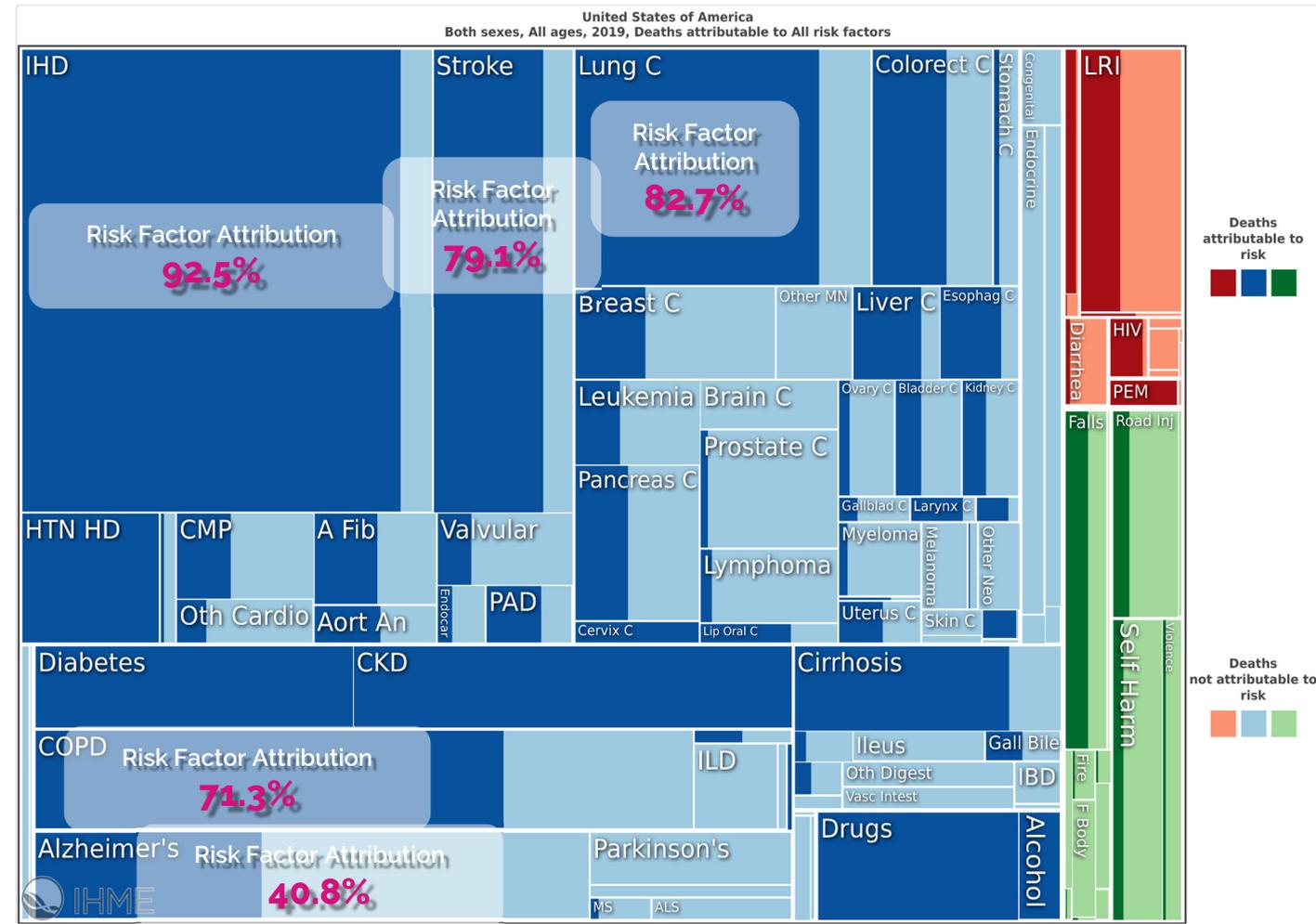
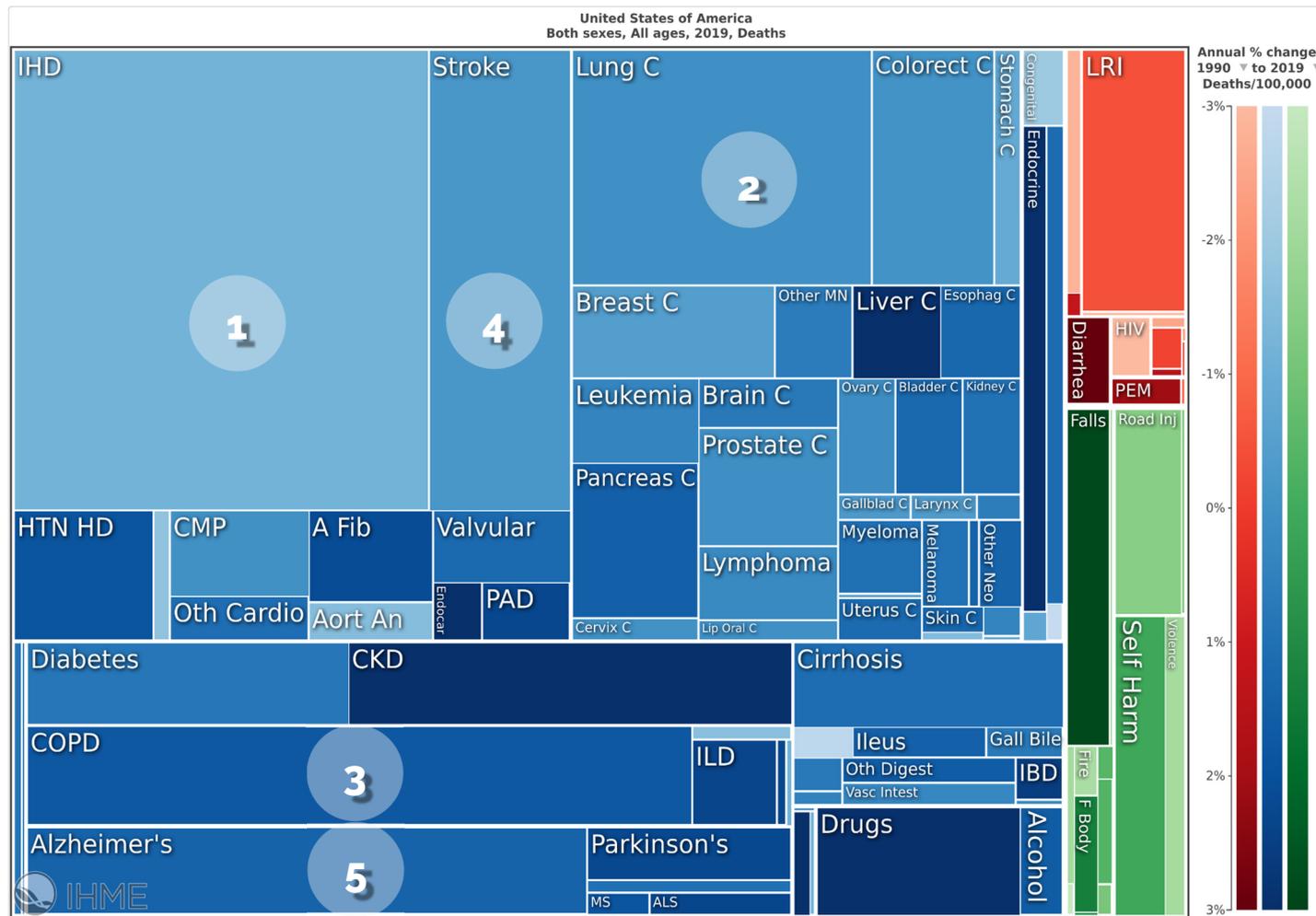
The Lancet Public Health Research Paper 4³

1. [https://www.thelancet.com/journals/lancet/issue/vol392no10159/PIIS0140-6736\(18\)X0048-8](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](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

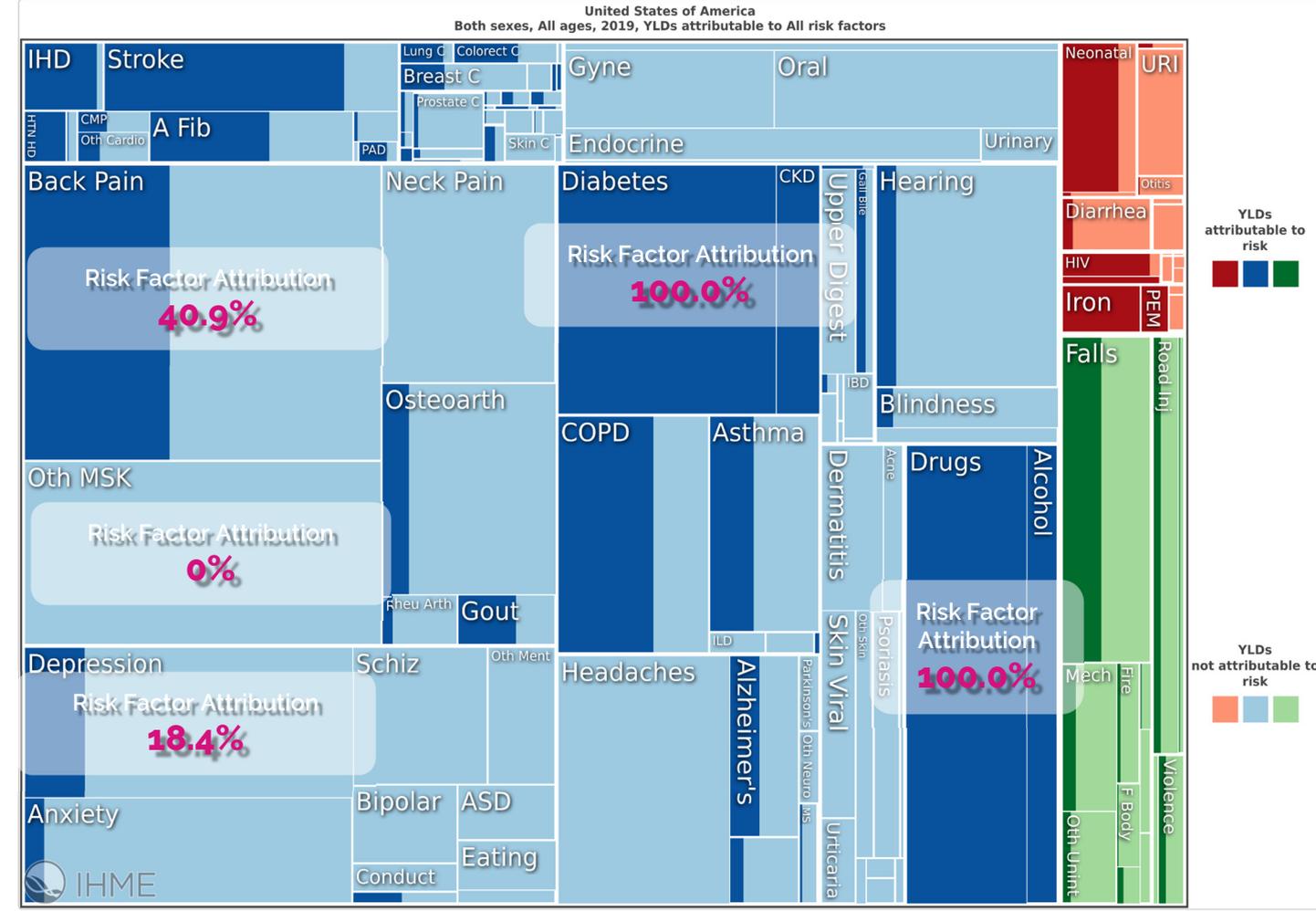
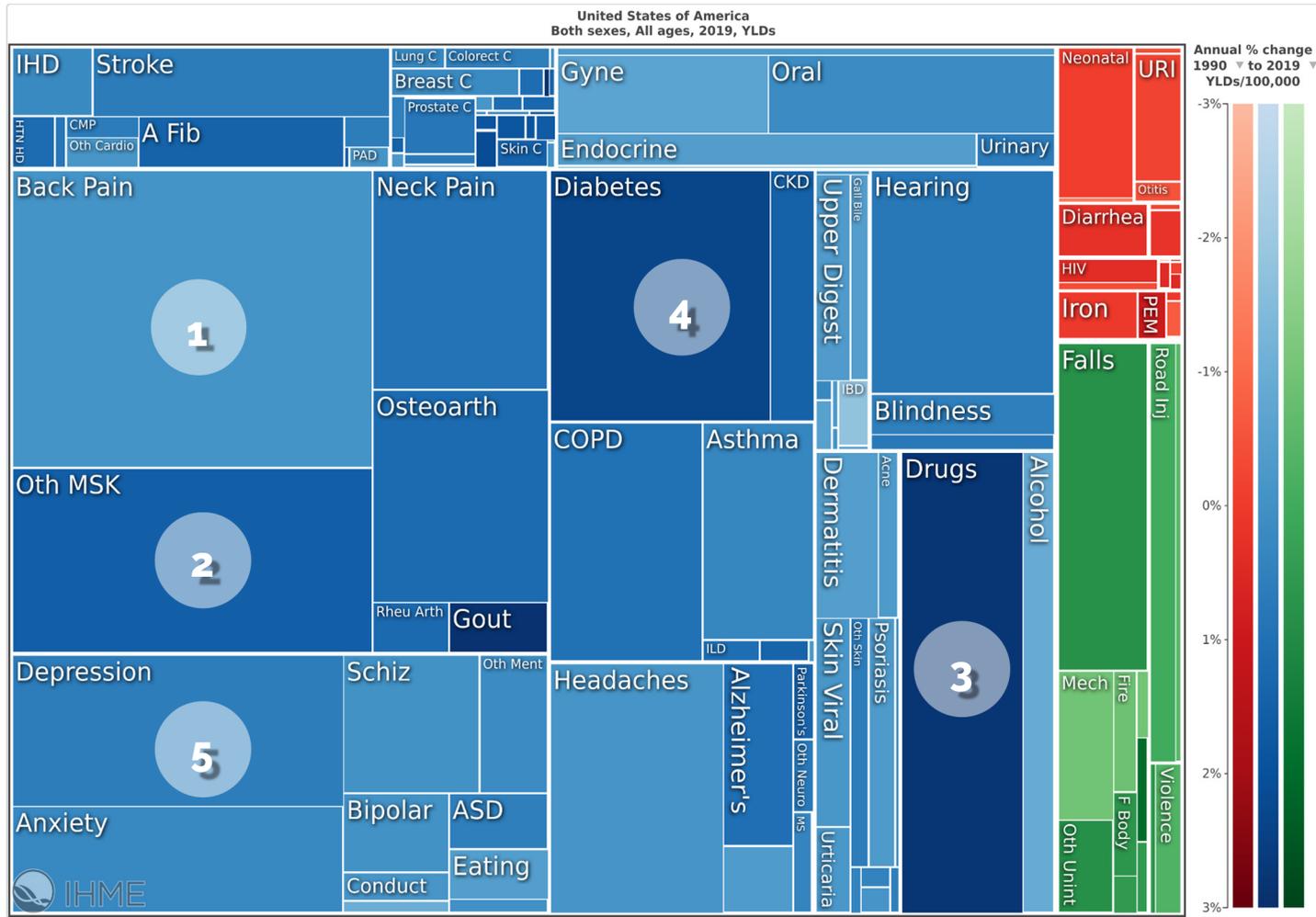
Aggregate Risk Factor Attributions

	$f(...)$						
	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		

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



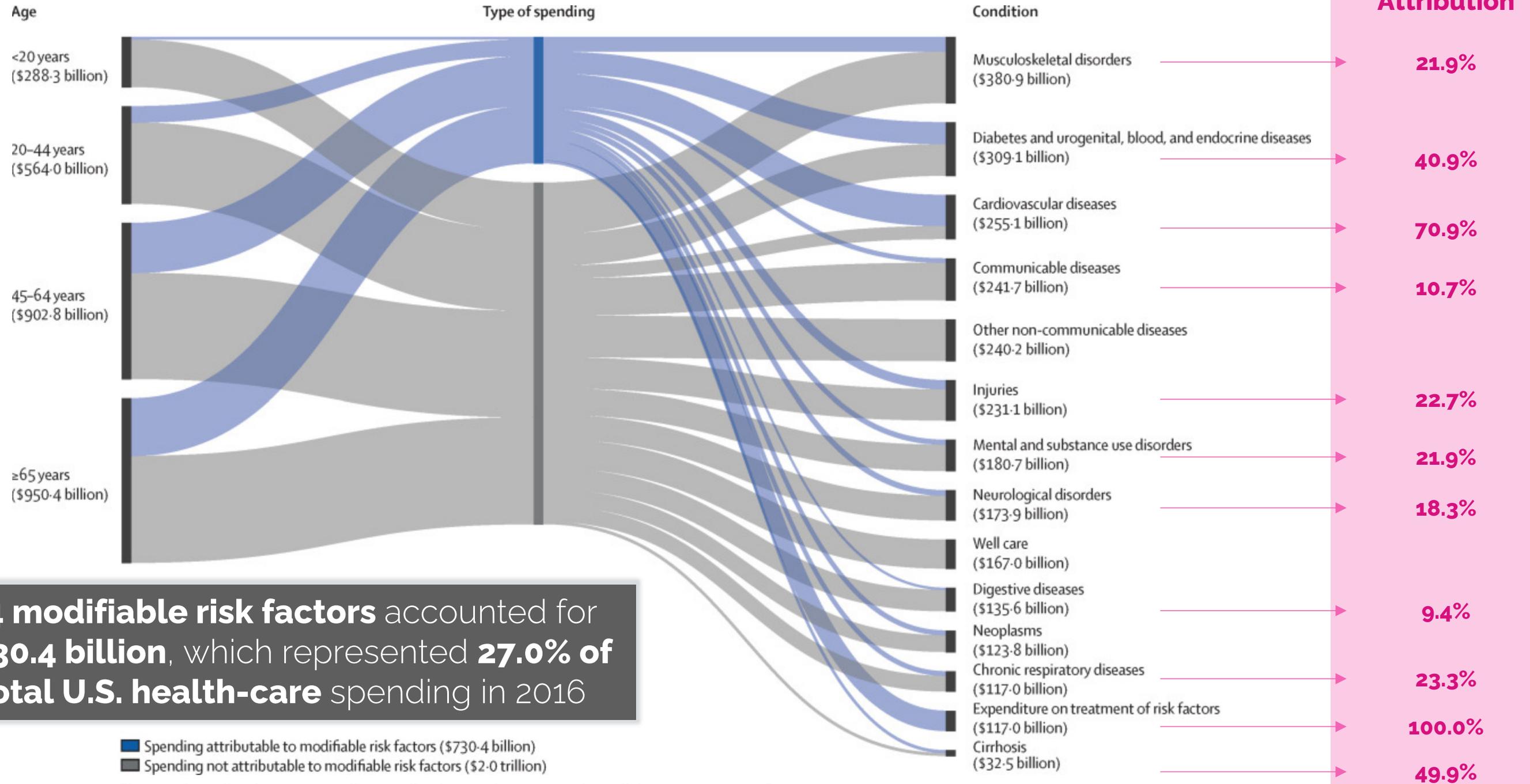
Attributable Modifiable Risk Factors

Aggregate Risk Factor Attributions

	f(...)								
	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

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

■ Spending attributable to modifiable risk factors (\$730.4 billion)
 ■ Spending not attributable to modifiable risk factors (\$2.0 trillion)

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

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

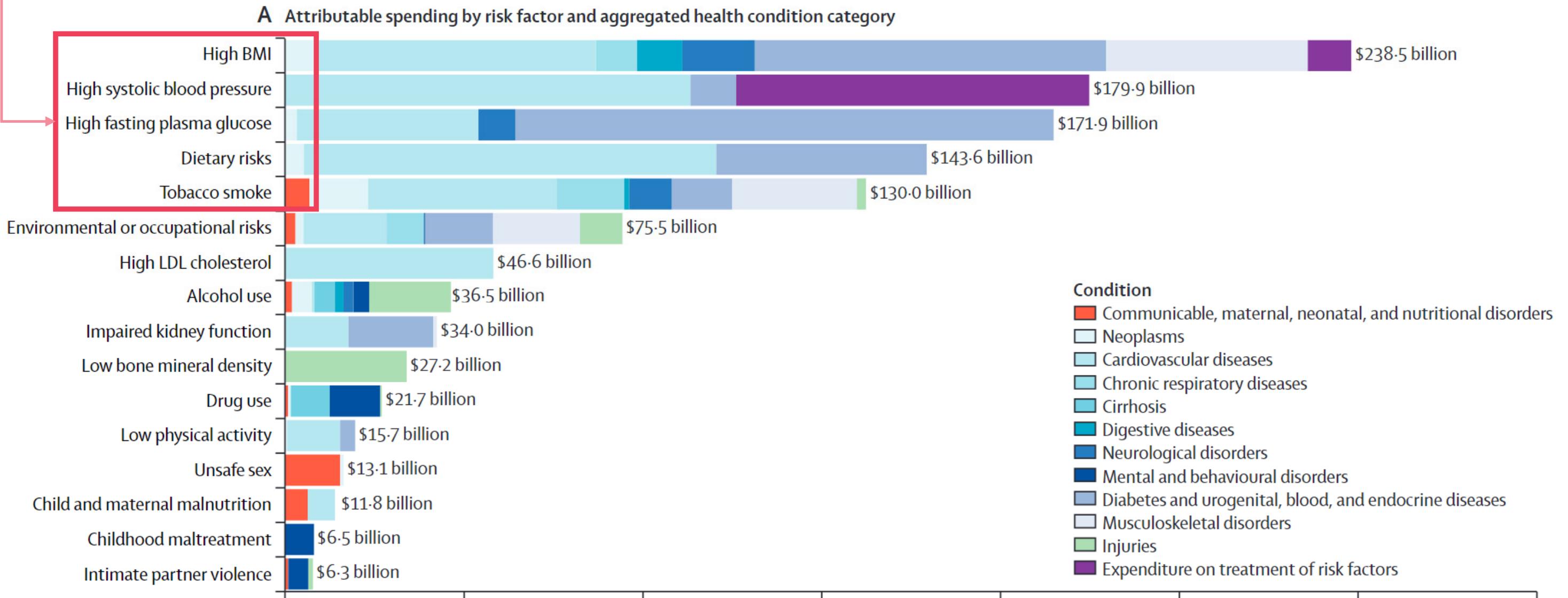


Figure 2: Health-care spending attributable to risk factor categories by aggregated health condition (A) and age group (B), 2016

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

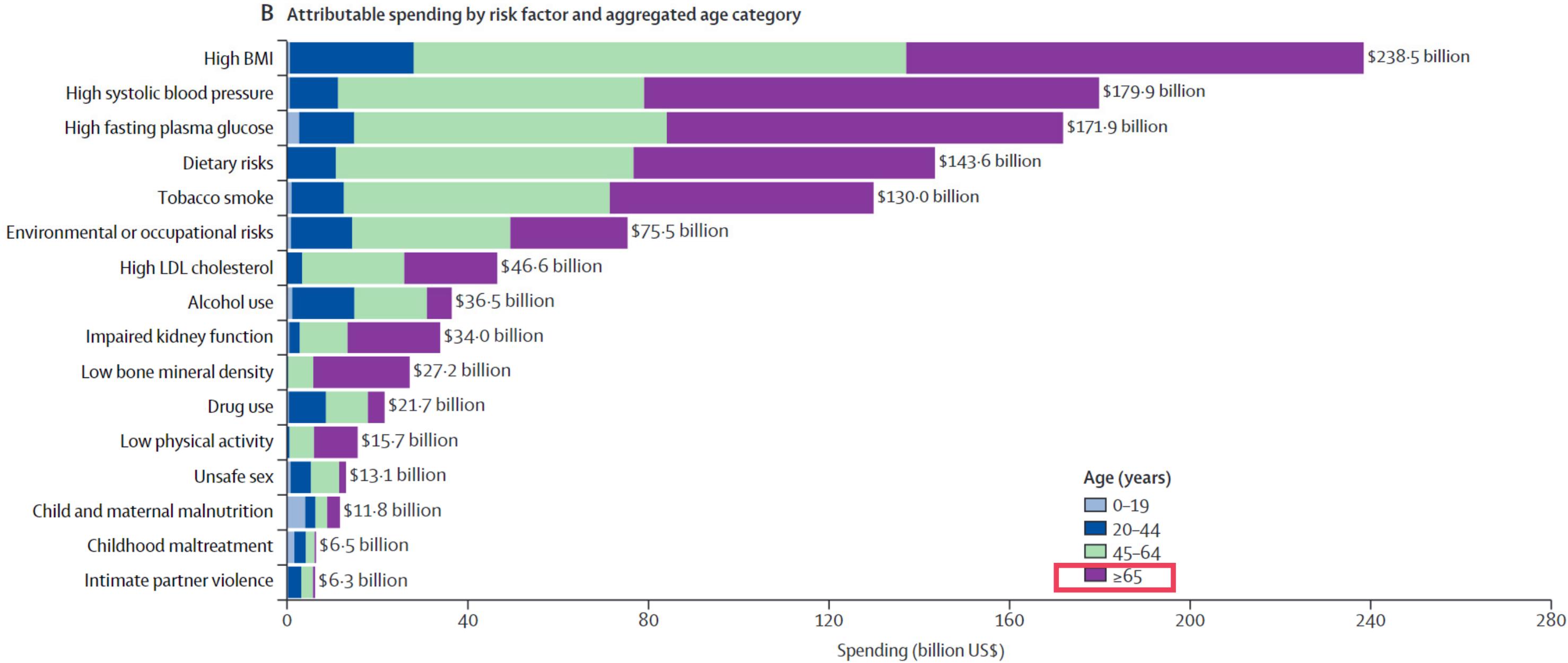
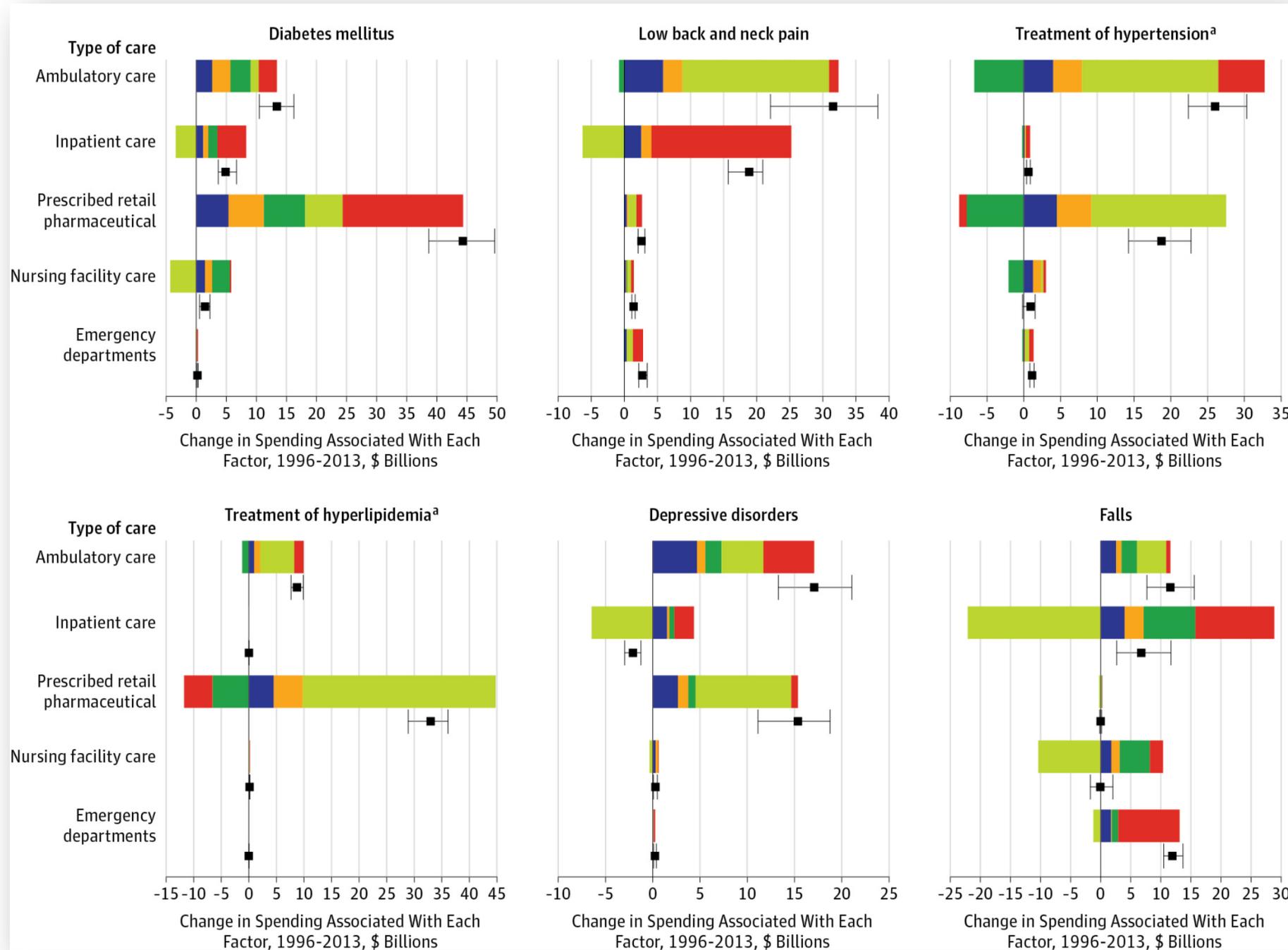


Figure 2: Health-care spending attributable to risk factor categories by aggregated health condition (A) and age group (B), 2016

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.

The Drivers of Health-Care Spending Increases



Original Investigation
November 7, 2017

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

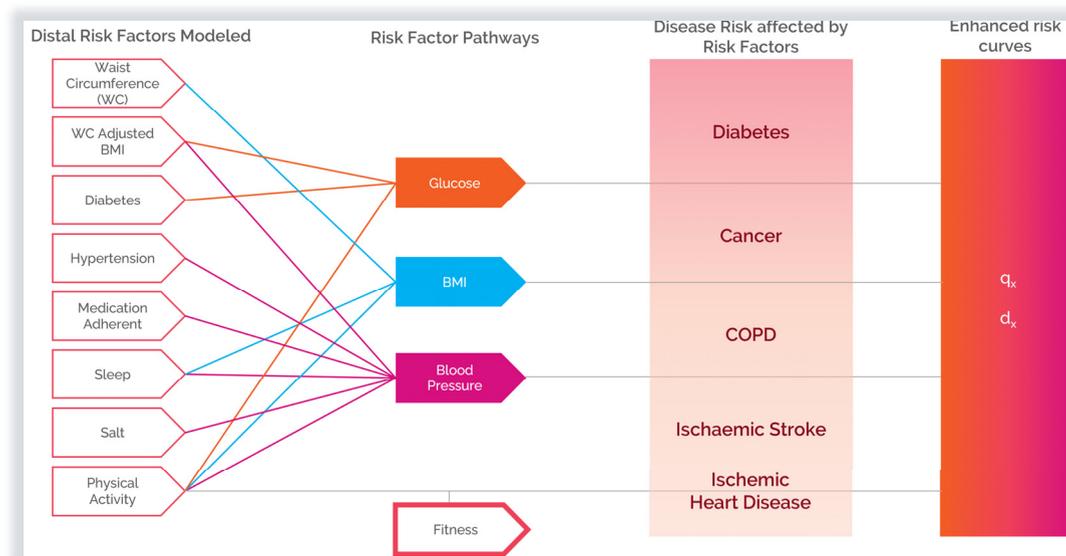
Joseph L. Dieleman, PhD¹; Ellen Squires, MPH¹; Anthony L. Bui, MPH²; et al
 » Author Affiliations | Article Information
 JAMA. 2017;318(17):1668-1678. doi:10.1001/jama.2017.15927

<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**

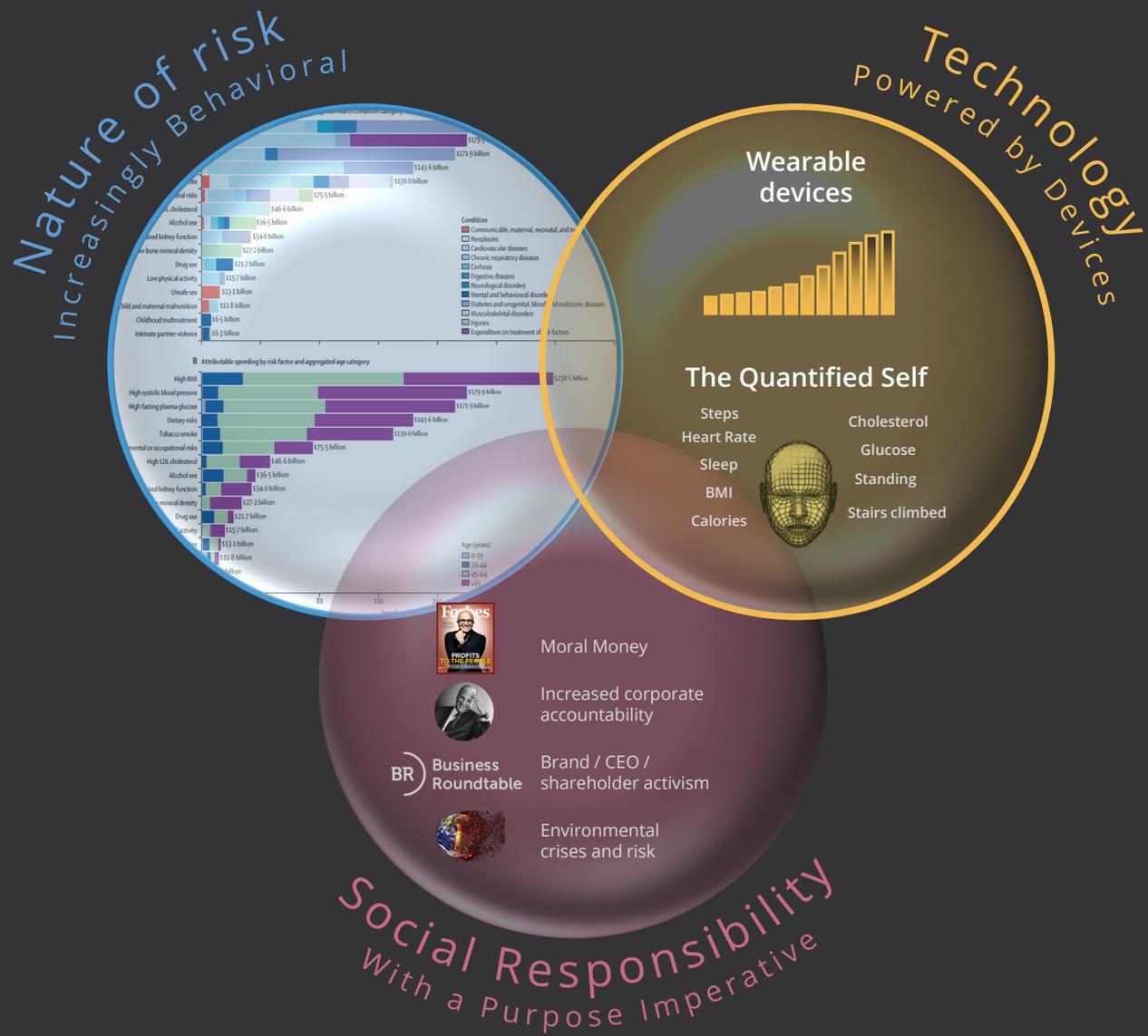
Chapter 3

§ 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**

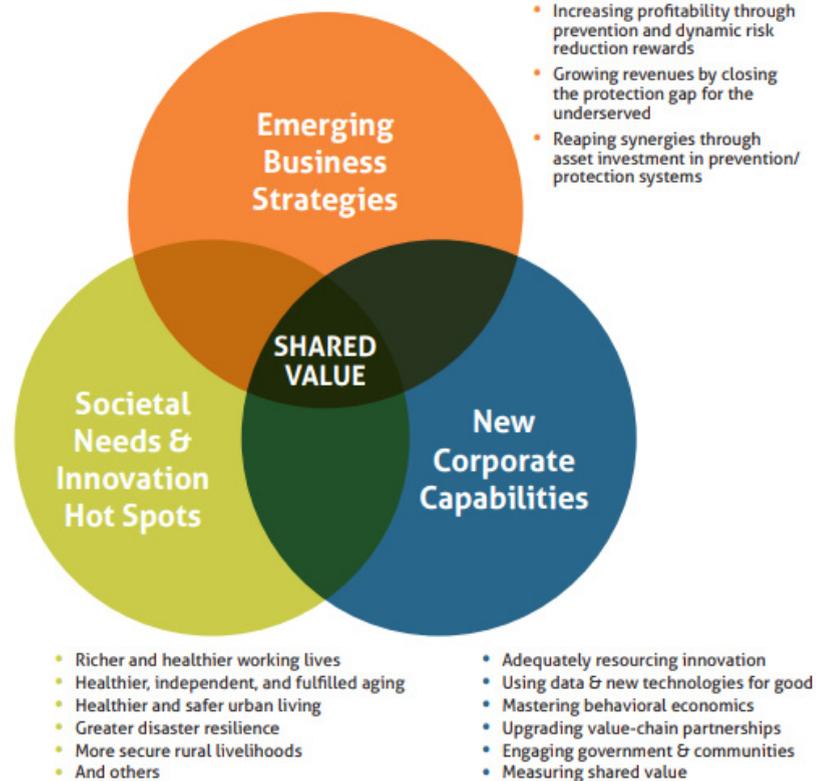


- Requires a robust understanding of modifiable risk factor that **cause** mortality and morbidity
- **Wearable devices** and other **enhanced consumer data** increasingly allow risk bearers to **monitor these causes**
- Which allows risk bearers to **identify** modifiable risks and **incentivize behavior 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**

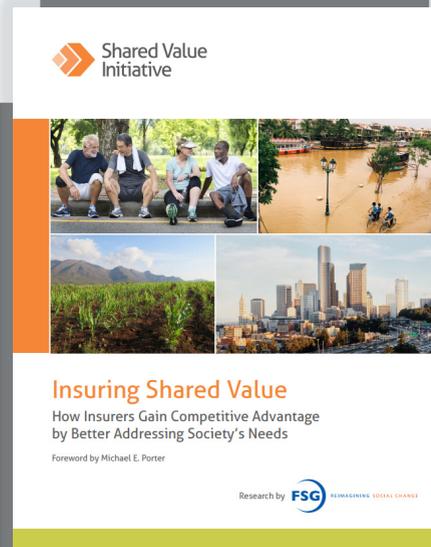


Through Products that **Incent Individuals** and **Create Shared Value**

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.



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