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The Global Burden of Stroke: The Stroke Belt and Global Stroke Disparities

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6/2/2022

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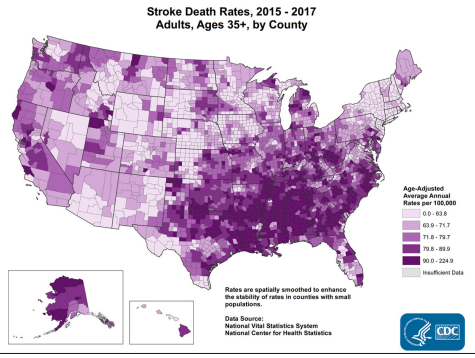
Stroke Belt



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Global Stroke Belt

- Ongoing pandemic of cardiovascular disease and stroke concentrated in the developing world
  - 5th leading cause of death in the US
  - But the 2nd leading cause of death worldwide
- But most relative improvements have been in high income countries where the burden of stroke is lower to begin with
  - Strong association between national income and favorable trends in stroke burden and vascular risk factors over the last 20 years
- Population growth and population aging are major contributors to the projected global stroke burden in the coming years

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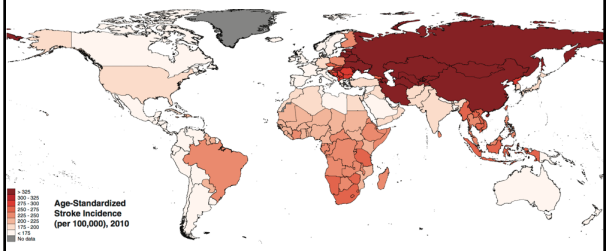
Global Stroke Belt



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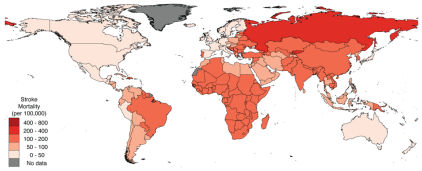
Mortality Rates for Stroke



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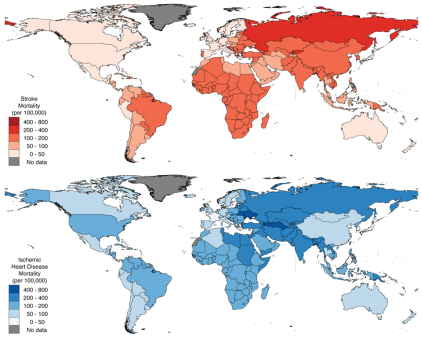
Mortality Rates for Stroke and Heart Disease



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Kim and Johnston, *Circulation* 2011

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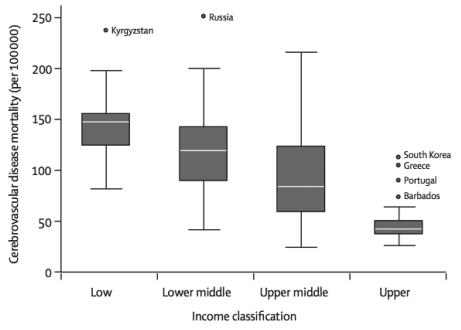
Stroke Mortality Rate by National Income



Johnston et al, *Lancet* 2009 UCSF

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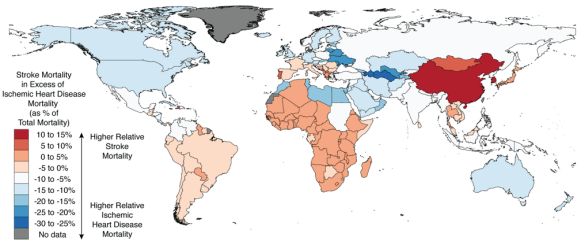
Stroke vs. Ischemic Heart Disease Mortality Rate



Kim and Johnston, *Circulation* 2011 UCSF

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Stroke in China

- 2.5 million new strokes/year
- 1.6 million stroke deaths/year
  - Leading cause of death (>> ischemic heart disease)
  - Higher proportion of hemorrhagic strokes
- 10x cost of stroke compared to heart disease
- 50% increase in stroke incidence projected from 2010 to 2030

Liu et al. *Stroke* 2011; Moran et al., *Circulation: Cardiovascular Quality and Outcomes*, 2010 UCSF

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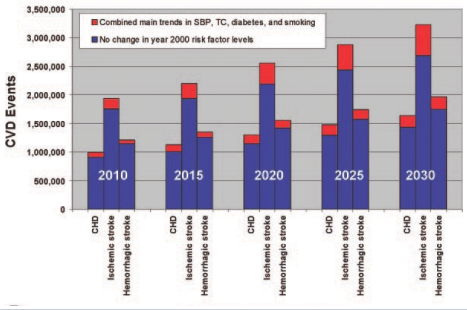
Projected Increase in CV Events (China 2010-2030)



Moran et al., *Circulation: Cardiovascular Quality and Outcomes*. 2010

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What the future holds…

- Infectious disease → cardiovascular disease (i.e. epidemiologic transition)

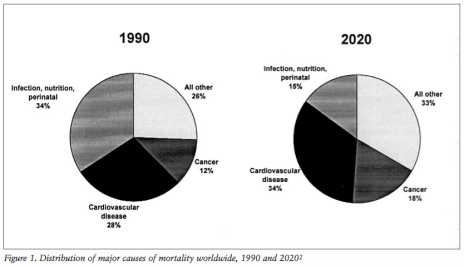

Figure 1. Distribution of major causes of mortality worldwide, 1990 and 2020

Levenson et al. *Preventive Cardiology* 2002

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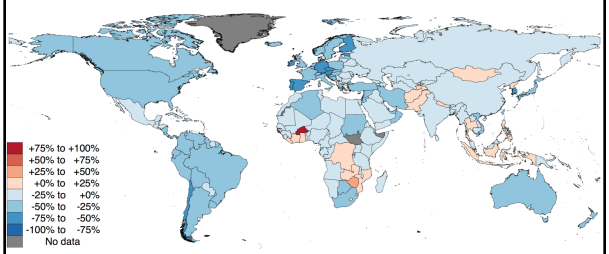
Age-Standardized Stroke Mortality Rate

Relative Change, 1990-2010



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Age-Standardized Mortality Rate

(Per 100,000)

Rank	Country	1990	2010	Δ%
1	Qatar	66.6	22.4	-66.4
2	South Korea	218.1	77.4	-64.5
3	The Bahamas	103.3	37.6	-63.6
4	Austria	78.7	33.4	-57.5
5	Portugal	170.3	72.8	-57.3
...	***Median***	***112.2***	***89.8***	***-23.0***
182	Ghana	110.0	120.0	+9.1
183	Congo, DRC	115.8	131.1	+13.2
184	Philippines	89.7	109.6	+22.2
185	Zimbabwe	83.9	115.8	+38.1
186	Burkina Faso	59.0	105.4	+78.8

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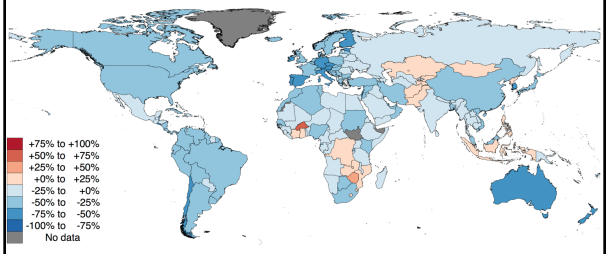
Age-Standardized Stroke DALY Loss Rate

Relative Change, 1990-2010



DALY=disability-adjusted life year

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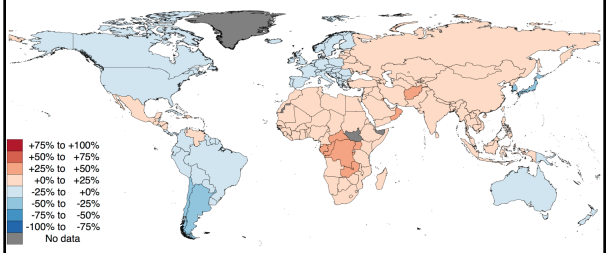
Age-Standardized Stroke Incidence Rate

Relative Change, 1990-2010



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Age-Standardized Stroke Incidence

(per 100,000)

Rank	Country	1990	2010	Δ%
1	South Korea	247.5	175.3	–29.2
2	Brunei	246.8	177.2	–28.2
3	Japan	262.5	192.5	–26.7
4	Argentina	211.8	156.3	–26.2
5	Singapore	229.1	169.3	–26.1
…	***Median***	***194.3***	***217.1***	***+10.1***
182	Burundi	189.3	238.0	+25.7
183	Gabon	186.9	236.3	+26.4
184	Congo	190.4	241.2	+26.7
185	Oman	143.1	184.9	+29.2
186	Congo, DRC	181.3	237.9	+31.2

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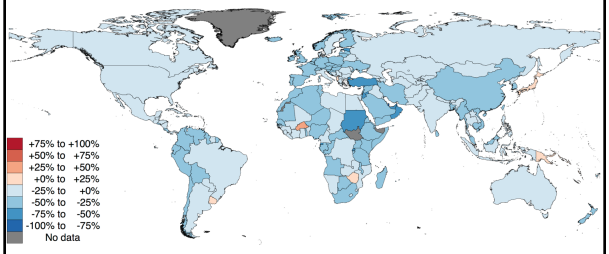
Stroke Mortality to Incidence Ratio

Relative Change, 1990-2010



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Changes from 1990-2010

Most stroke indicators have improved in most countries

- Age-standardized stroke mortality rate declined in 164/186 (88%)
  - Median decrease of 23%
- Age-standardized DALY loss rate declined in 168/186 (90%)
  - Median decrease of 26%
- Mortality-to-incidence ratio declined in 175/186 (94%)
  - Median decrease of 25%
- Age-standardized stroke incidence rate declined in 76/186 (40%)
  - Median increase of 10%

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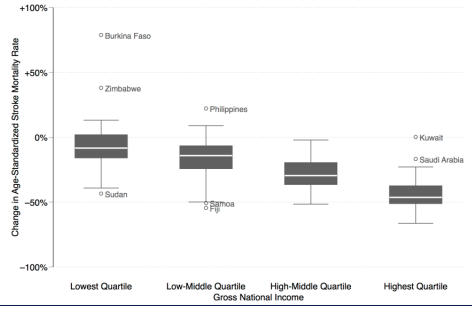
Change in Stroke Mortality Rate by GNI

1990-2010



GNI = Gross National Income Per Capita

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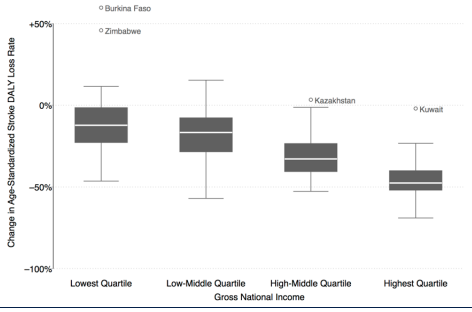
Change in Stroke DALY Loss Rate by GNI

1990-2010



DALY = Disability-Adjusted Life Year; GNI = Gross National Income Per Capita

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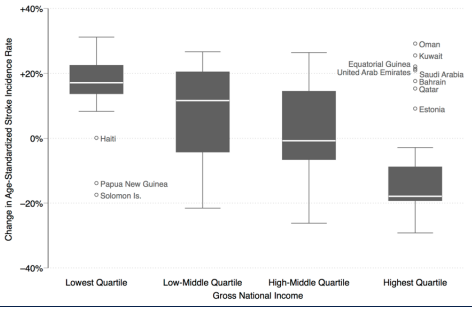
Change in Stroke Incidence Rate by GNI

1990-2010



GNI = Gross National Income Per Capita

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Recent Trends

- Despite the higher baseline burden of disease from stroke in countries with lower national income
- Lower national income was associated with less relative improvement

Median Change in Age-Standardized Stroke Indicators, 1990 to 2010

GNI	Mortality*	Incidence*	DALY Loss *
Lowest Quartile	–4.2%	+17.1%	–10.8%
Low Middle Quartile	–13.0%	+5.0%	–13.0%
High Middle Quartile	–27.0%	+0%	–34.1%
Highest Quartile	-45.0%	-17.0%	–46.5%
	p<0.001*	p<0.001*	p<0.001*

*Cuzick's test of trend; DALY= Disability Adjusted Life-year

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Factors Impacting Stroke Disease Burden

Demographic Factors	Non-Demographic Factors	
	Health Sector	Non-Health Sector
Population Growth	Healthcare Access	Economic Development
Aging	Treatment	Education
	Risk Factors	Social Safety Net
	etc…	etc…

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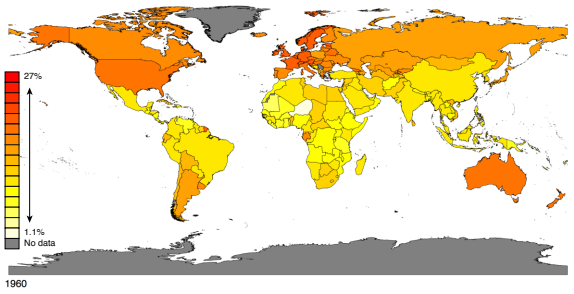
% of Population Age > 65 (1960-2015)



UN, Dept of Economic & Social Affairs, Population Division (2015). World Population Prospects: 2015 Revision

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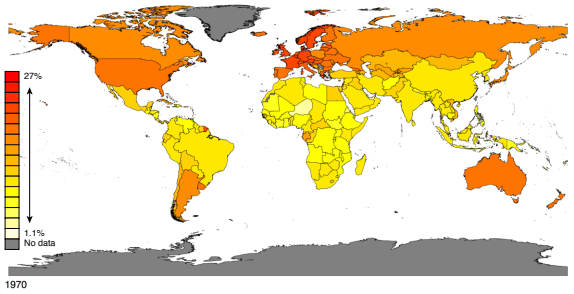

UN, Dept of Economic & Social Affairs, Population Division (2015). World Population Prospects: 2015 Revision

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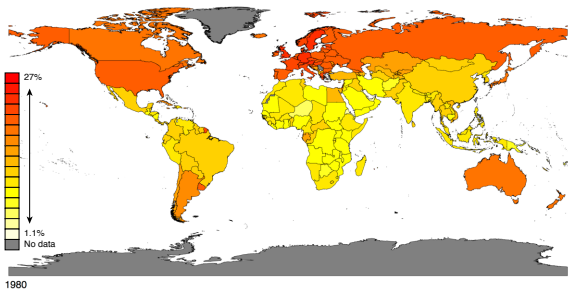

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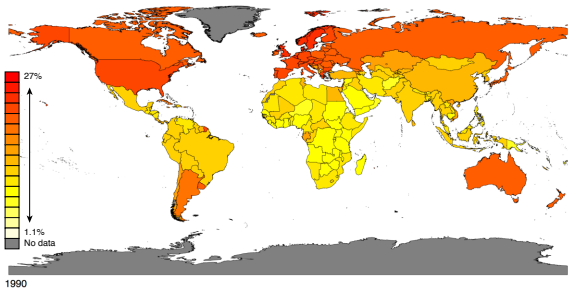

UN, Dept of Economic & Social Affairs, Population Division (2015). World Population Prospects: 2015 Revision

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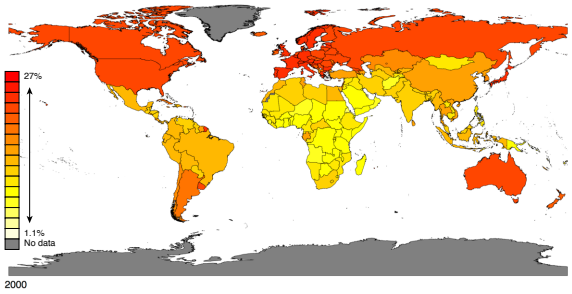

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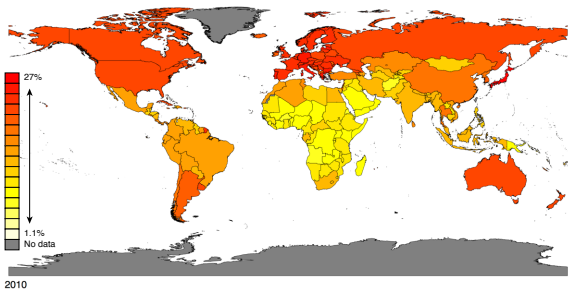

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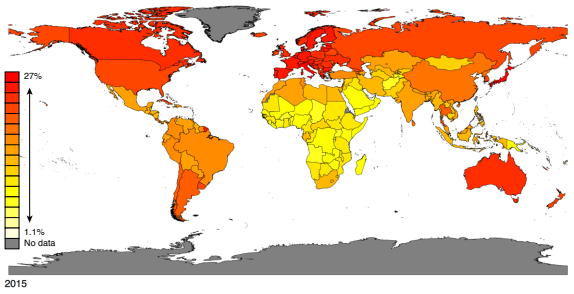

UN, Dept of Economic & Social Affairs, Population Division (2015). World Population Prospects: 2015 Revision

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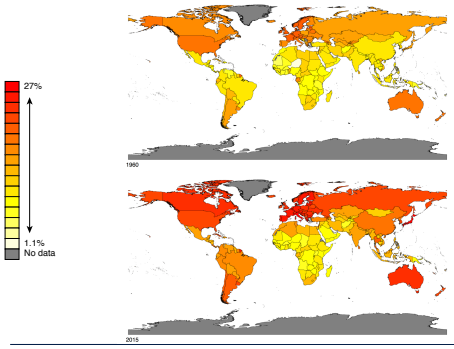
% of Population Age > 65 (1960-2015)



UN, Dept of Economic & Social Affairs, Population Division (2015). World Population Prospects: 2015 Revision

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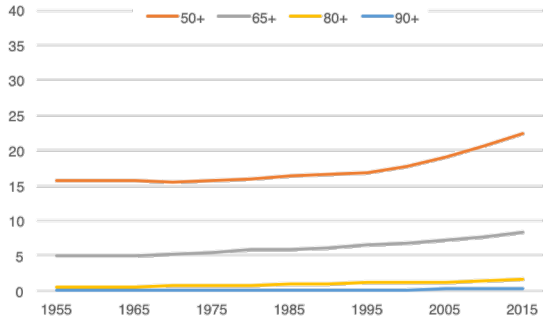
Aging Trends, Global



UN, Dept of Economic & Social Affairs, Population Division (2015). World Population Prospects: 2015 Revision

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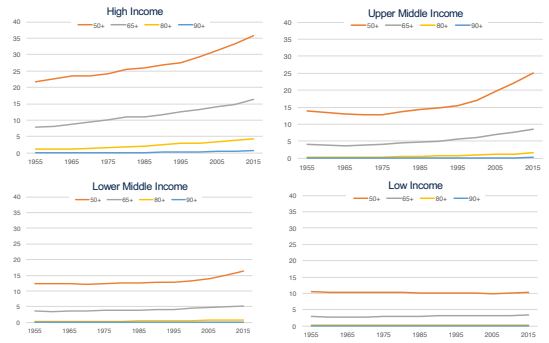
Aging Trends by National Income



UN, Dept of Economic & Social Affairs, Population Division (2015). World Population Prospects: 2015 Revision

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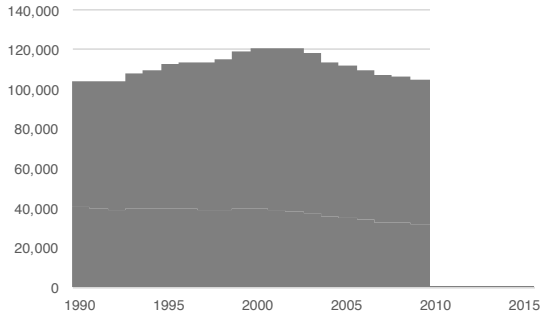
Ischemic Stroke Deaths, US 1990-2015



Data Source: IHME GBD

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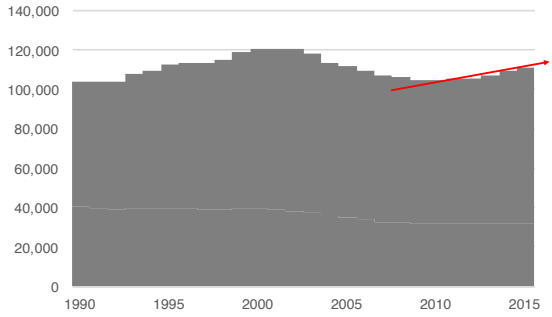
Ischemic Stroke Deaths, US 1990-2015



Data Source: IHME GBD

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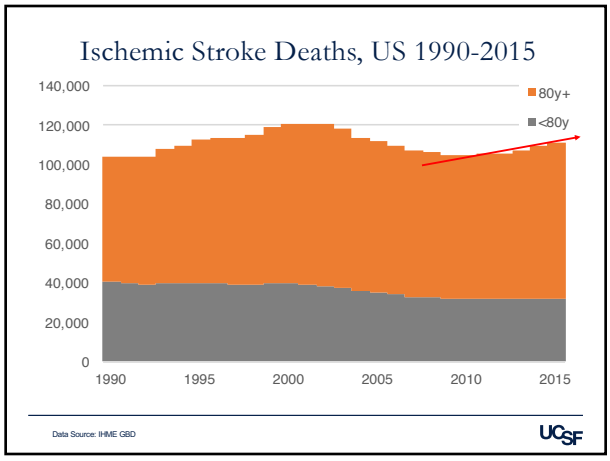
Ischemic Stroke Deaths, US 1990-2015
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1990
1995
2000
2005
2010
2015
80y+
<80y
Data Source: IHME GBD
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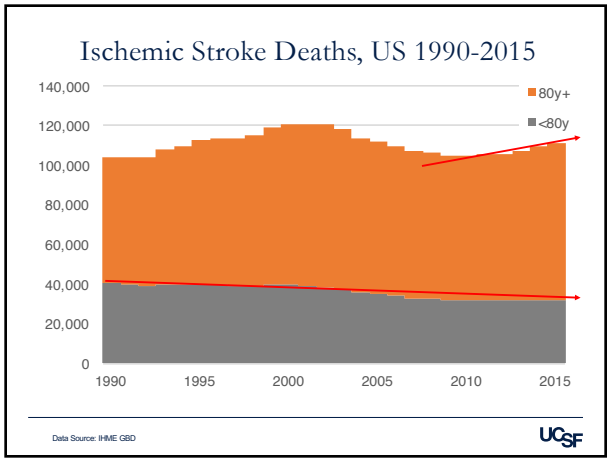
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UCSF

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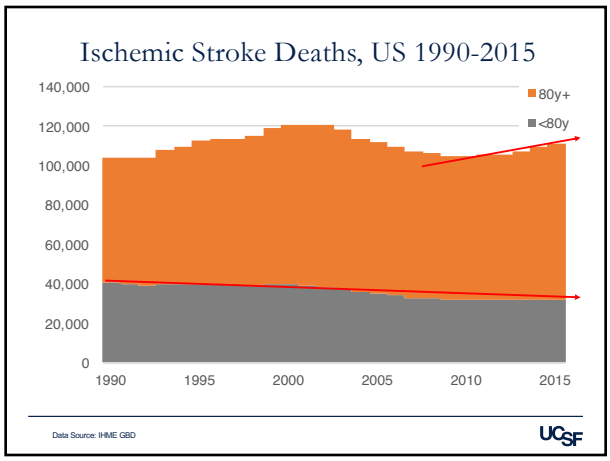
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80y+
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Data Source: IHME GBD
UCSF

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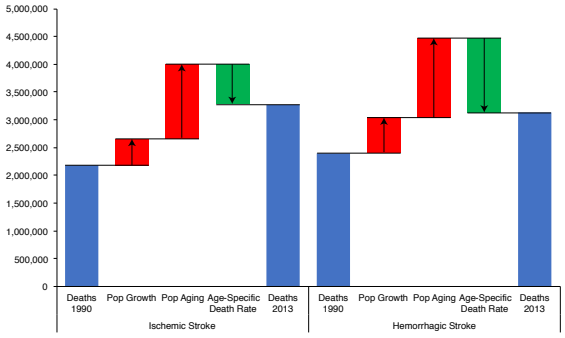
Global Deaths from Stroke (1990-2013)



Roth GA, Forouzanfar MH, Moran AE, et al. Demographic and Epidemiologic Drivers of Global Cardiovascular Mortality. N Engl J Med 2015;372:1333-41 UCSF

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Factors Impacting Stroke Disease Burden

Demographic Factors	Non-Demographic Factors	
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	etc…	etc…

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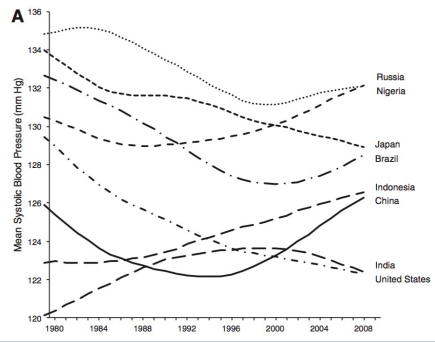
Mean Systolic Blood Pressure, 1980-2009



Kim AS, et al. Global Stroke Belt: Geographic Variation in Stroke Burden Worldwide. *Stroke*. 2015; Data Source: WHO Global Health Observatory UCSF

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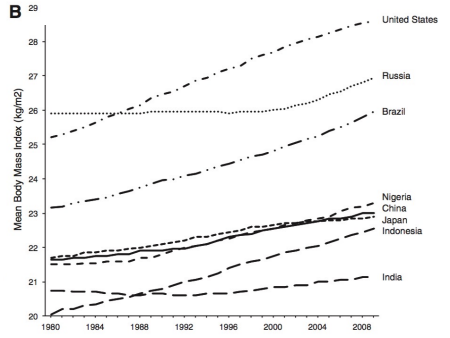
Mean BMI, 1980-2008



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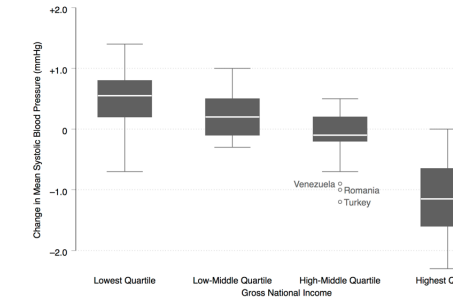
Change in Mean SBP by National Income

1990-2010



GNI = Gross National Income Per Capita

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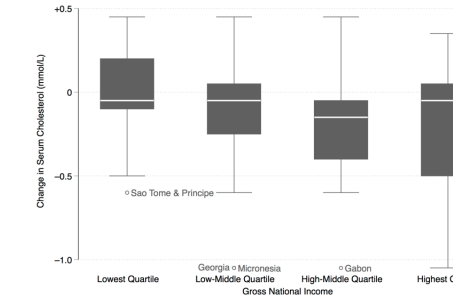
Change in Mean Serum Cholesterol by GNI

1990-2010



GNI = Gross National Income Per Capita

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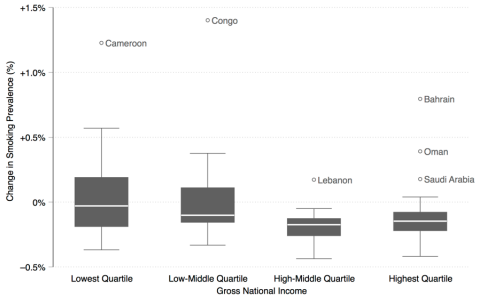
Change in Smoking Prevalence by GNI

1990-2010



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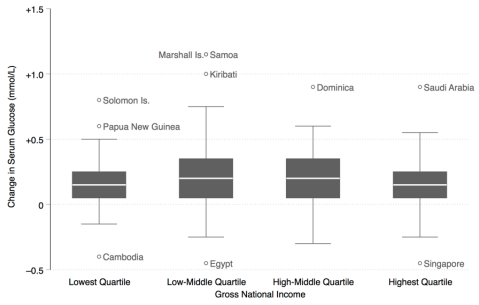
Change in Mean Fasting Glucose by GNI

1990-2010



GNI = Gross National Income Per Capita

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Vascular Risk Factors

- Higher national income associated with greater improvements in
  - Mean systolic blood pressure ($p<0.0001$)
  - Mean serum cholesterol ($p<0.0001$)
  - Mean smoking prevalence ($p=0.006$)
  - …but not mean fasting glucose ($p=0.43$)

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Conclusions

- The burden of disease from stroke continues to be disproportionately borne by low-income countries
  - But the largest relative improvements in stroke burden have been in higher income countries
- Partially mediated by favorable trends hypertension, cholesterol, and smoking (but not diabetes) in high income countries, and certain unfavorable trends in low income countries
- Population Growth and Population Aging are major contributors to the global pandemic of stroke
- Developing and sustaining interventions specifically for lower-income countries will be necessary

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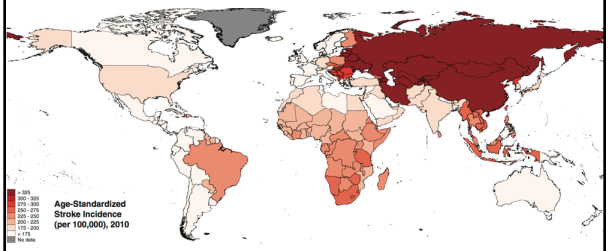
Global Stroke Belt



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