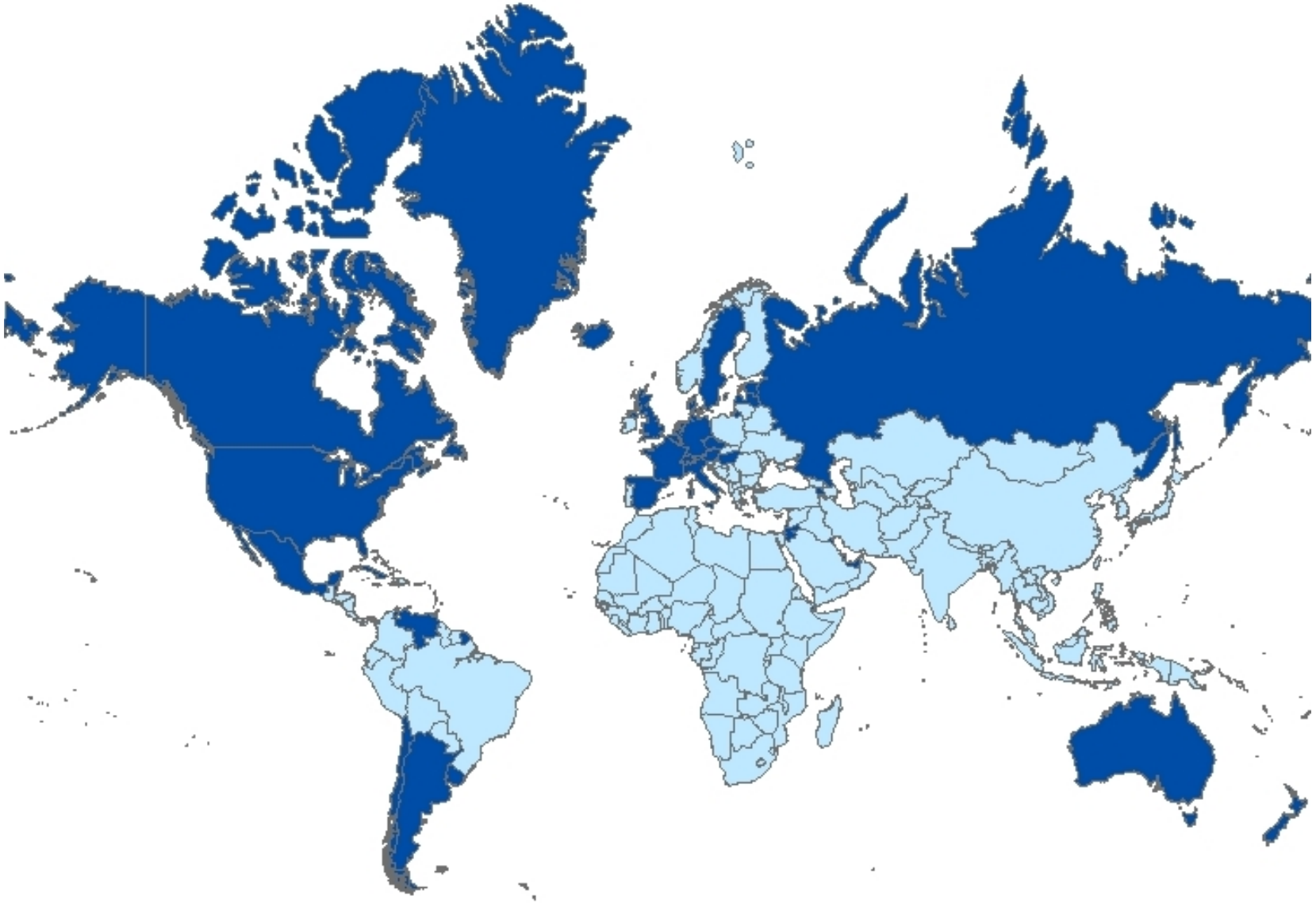
A population health science perspective on health in cities

Sandro Galea

Boston University School of Public Health

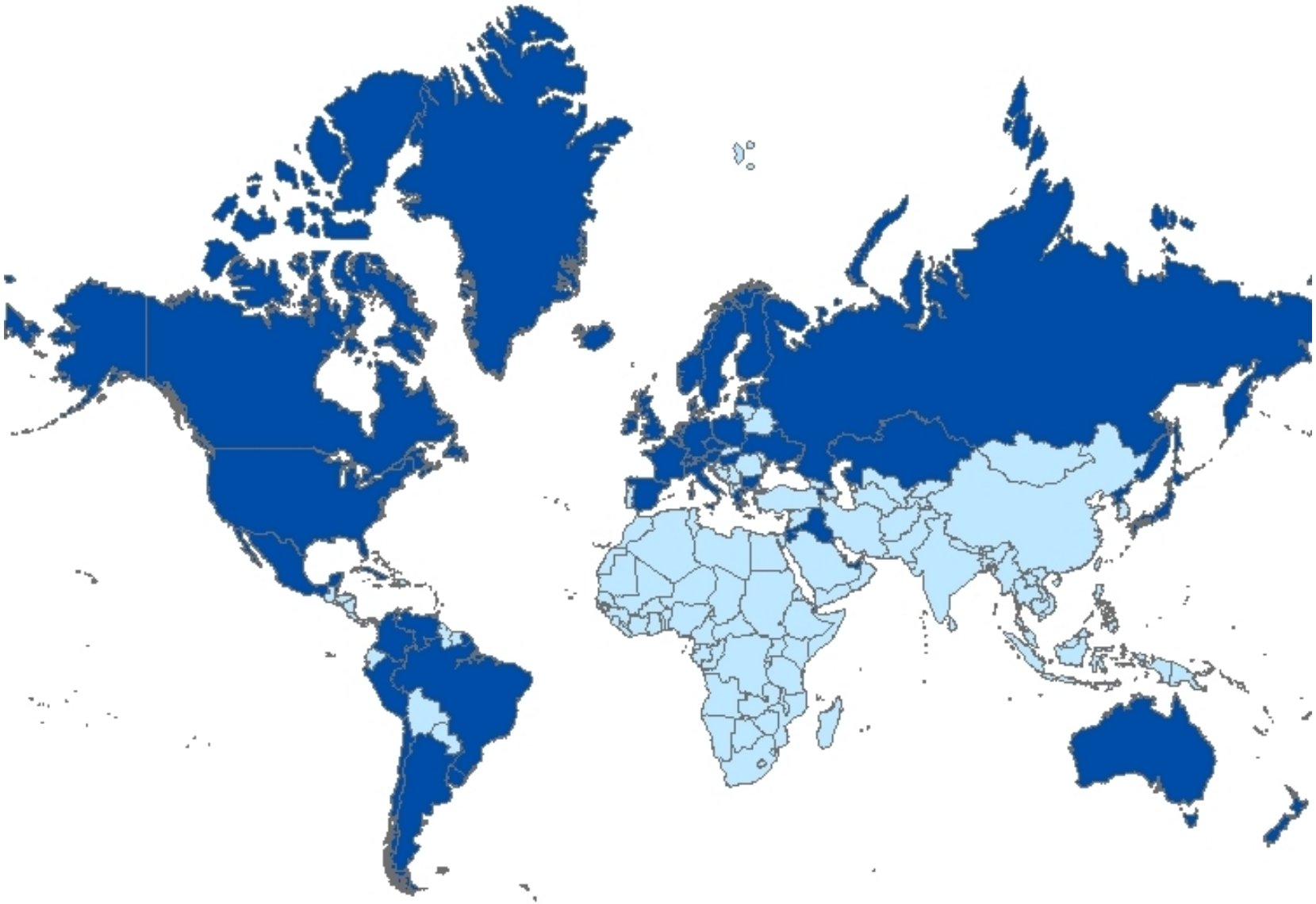
54% of the world's population currently lives in urban areas, and another 2.5 billion people are expected to be added to urban populations by 2050, surpassing 6 billion

More than 50% of the population is living in urban areas, 1960



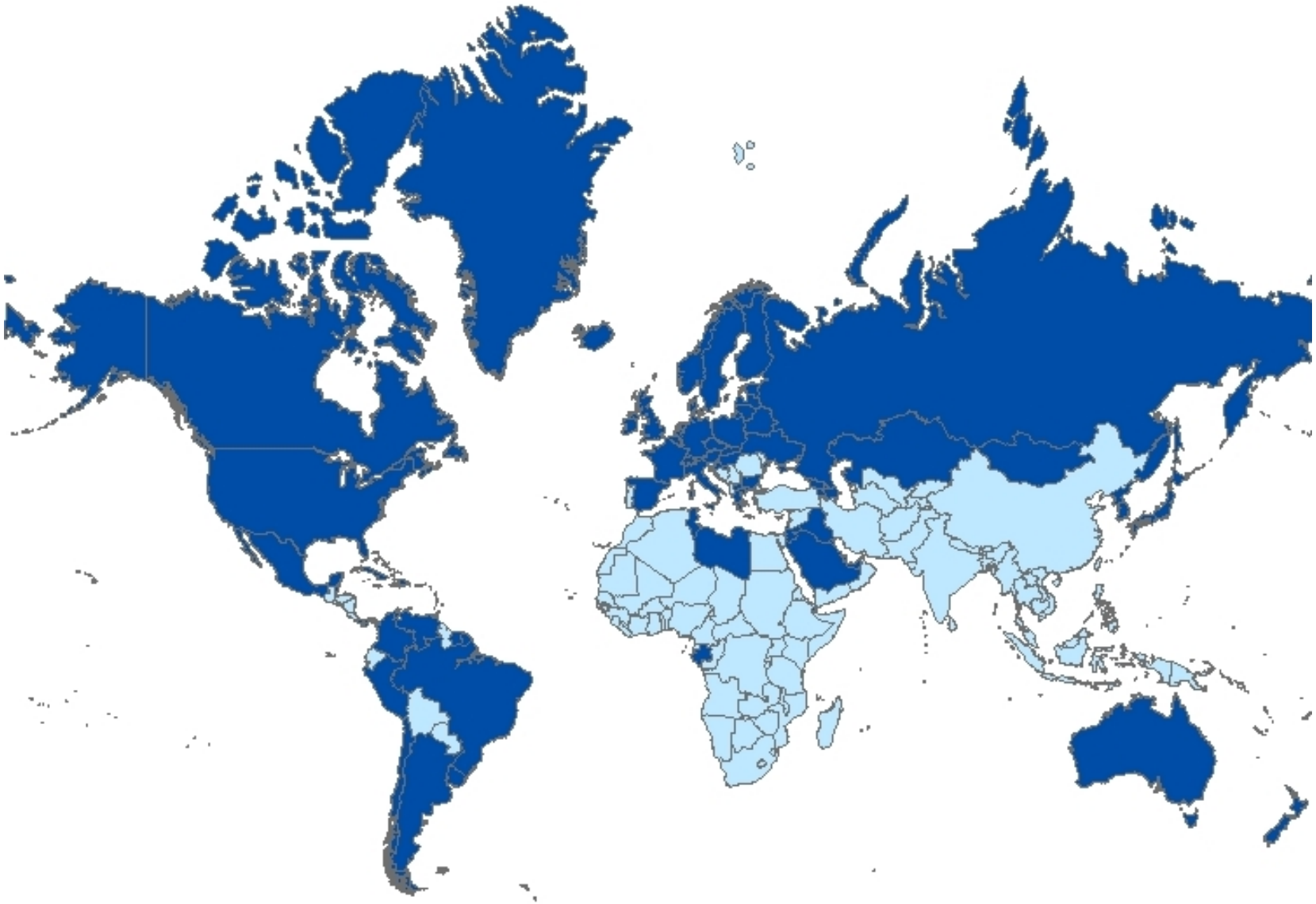
Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision. <http://esa/un.org/unup>

More than 50% of the population is living in urban areas, 1970



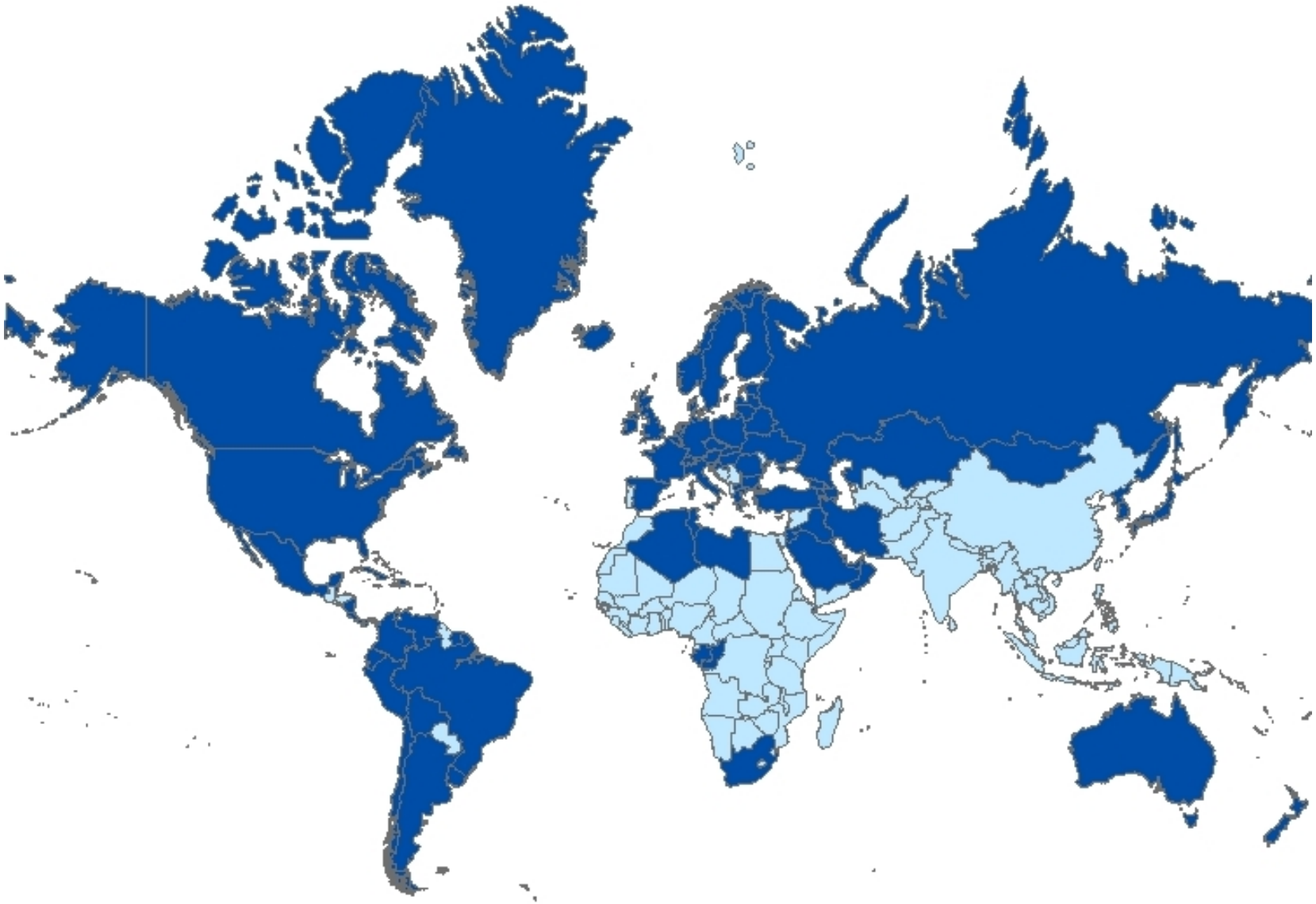
Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision. <http://esa/un.org/unup>

More than 50% of the population is living in urban areas, 1980



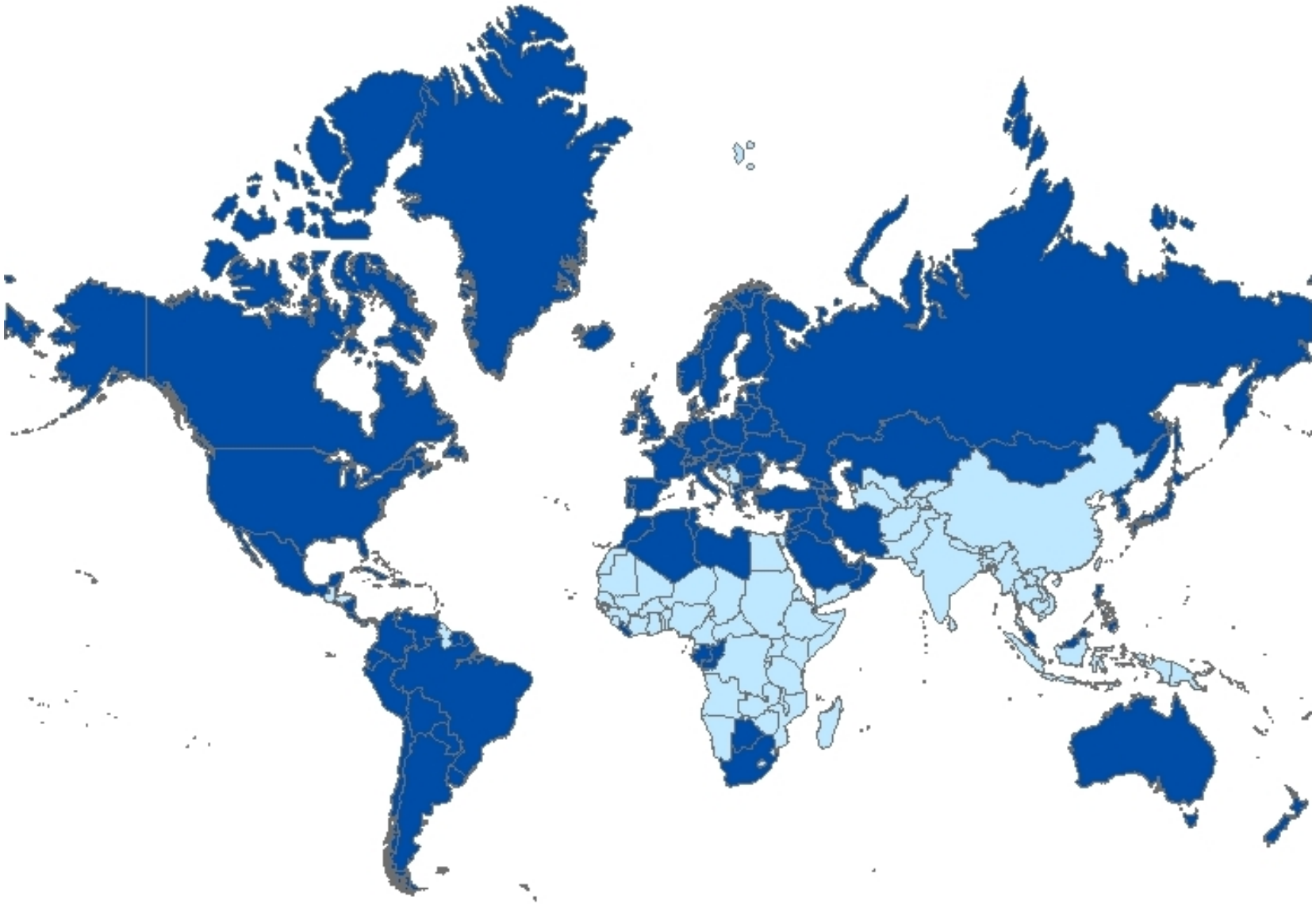
Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision. <http://esa/un.org/unup>

More than 50% of the population is living in urban areas, 1990



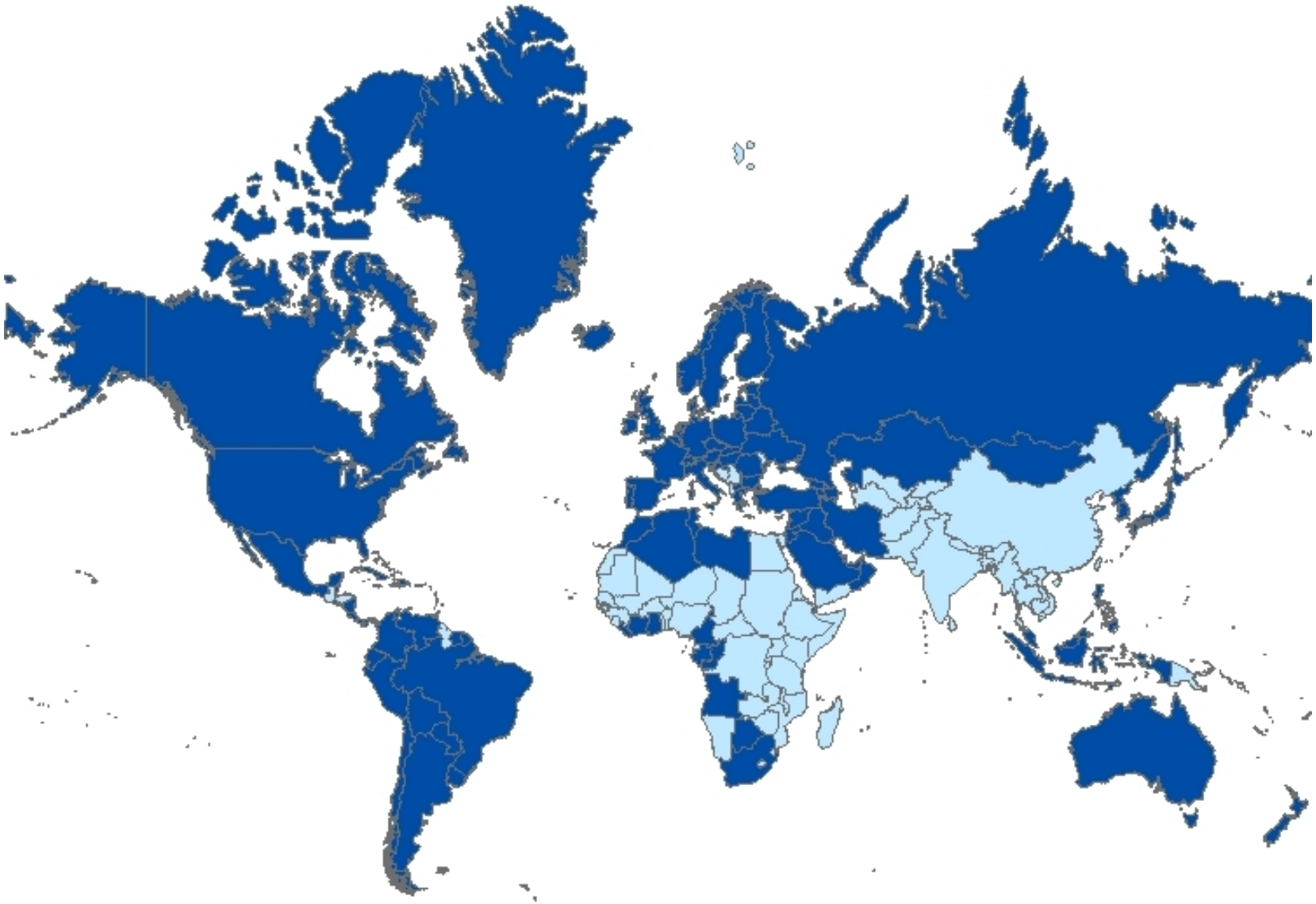
Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision. <http://esa/un.org/unup>

More than 50% of the population is living in urban areas, 2000



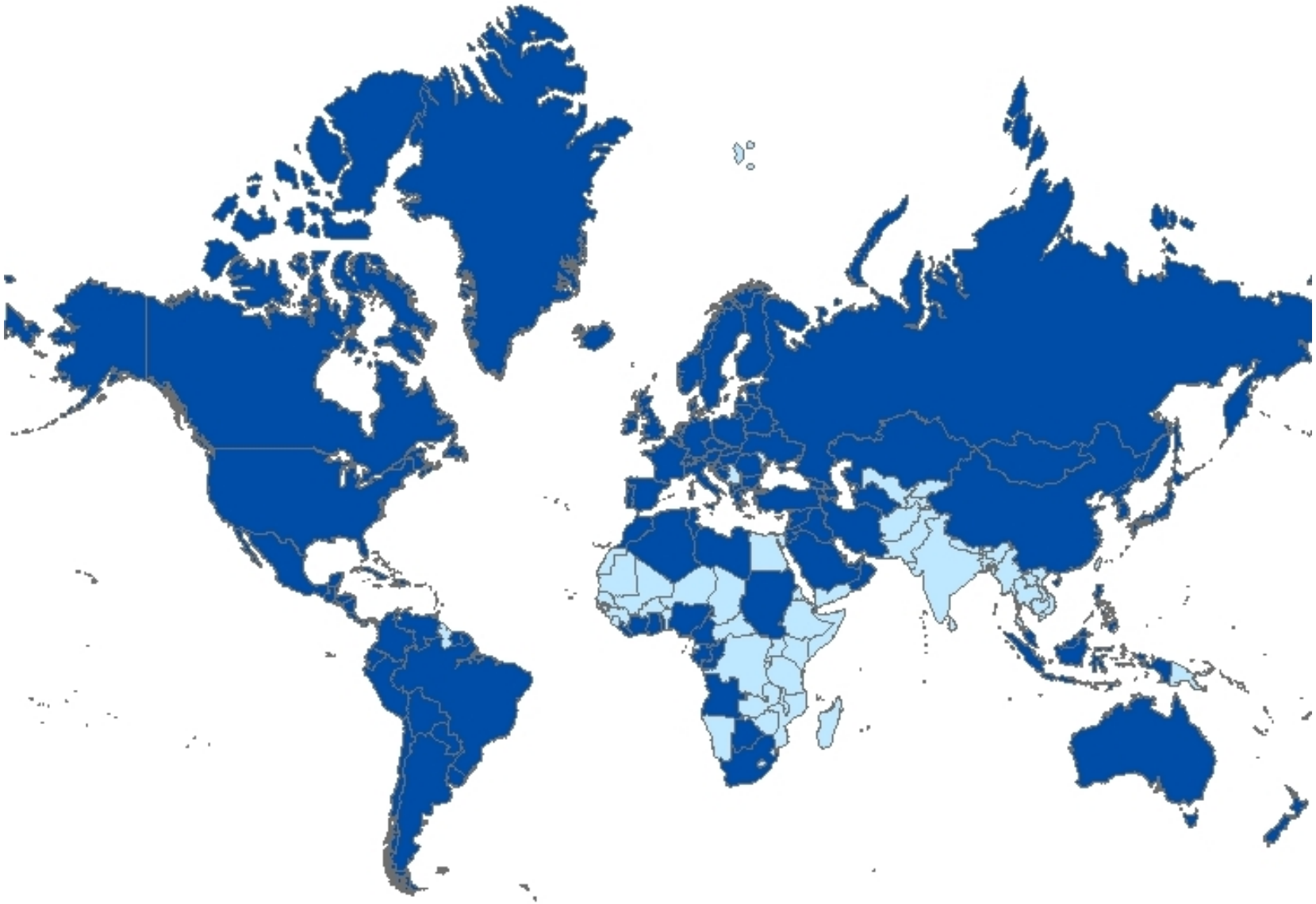
Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision. <http://esa/un.org/unup>

More than 50% of the population is living in urban areas, 2010



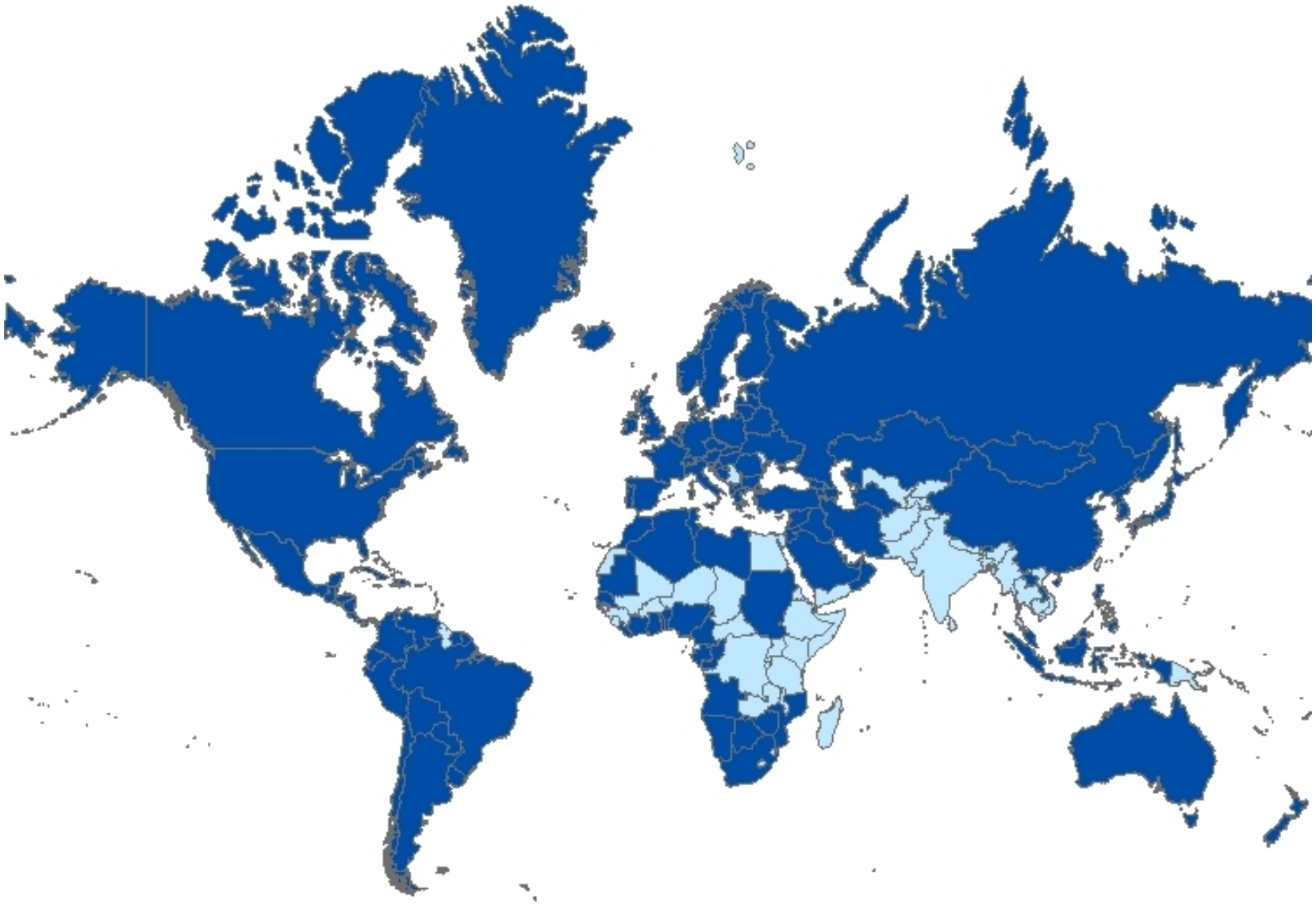
Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision. <http://esa/un.org/unup>

More than 50% of the population is living in urban areas, 2020



Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision. <http://esa/un.org/unup>

More than 50% of the population is living in urban areas, 2030



Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision. <http://esa/un.org/unup>

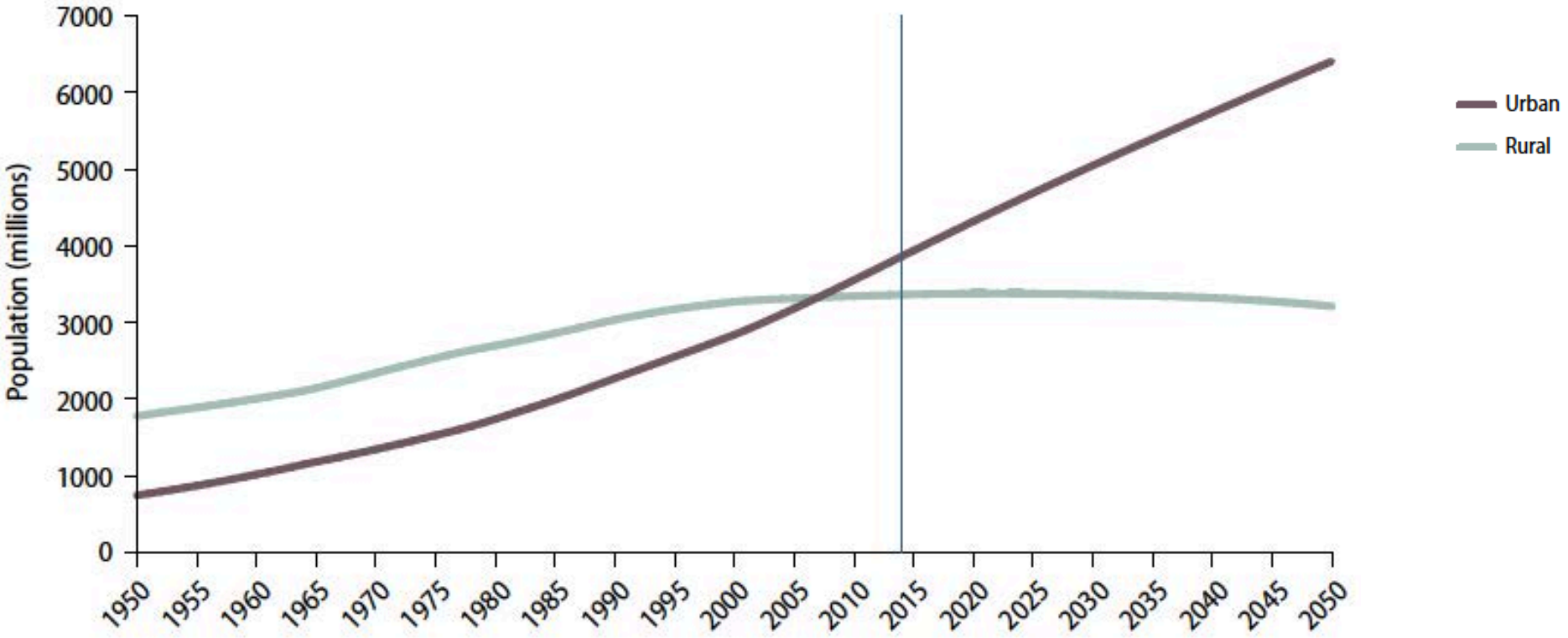
More than 50% of the population is living in urban areas, 2040

Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision. <http://esa/un.org/unup>

More than 50% of the population is living in urban areas, 2050

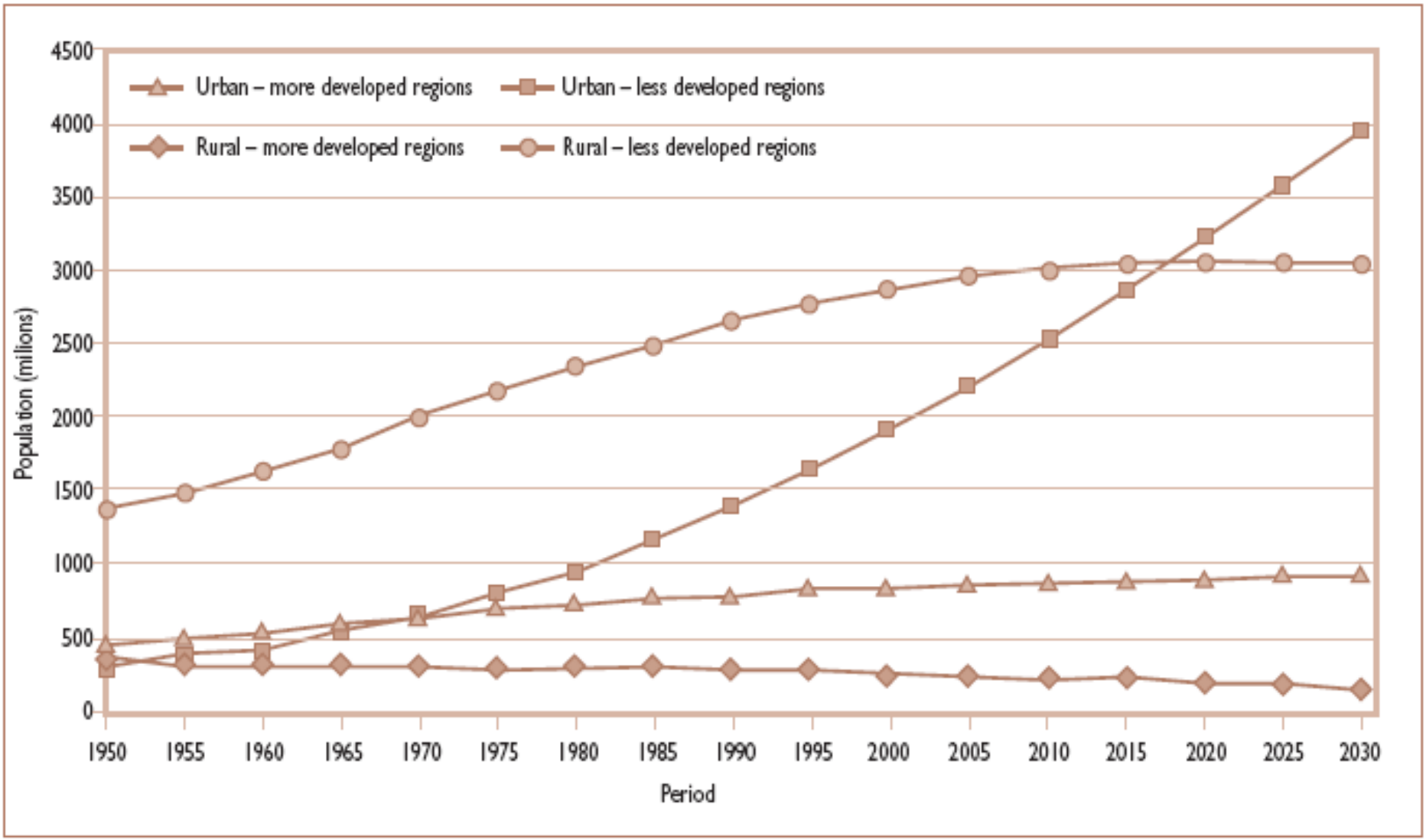
Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision. <http://esa/un.org/unup>

Urban and rural population of the world, 1950–2050



"World's population increasingly urban with more than half living in urban areas." July 10, 2014. United Nations Department of Economic and Social Affairs. <http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html> Accessed October 17, 2014. <http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf>

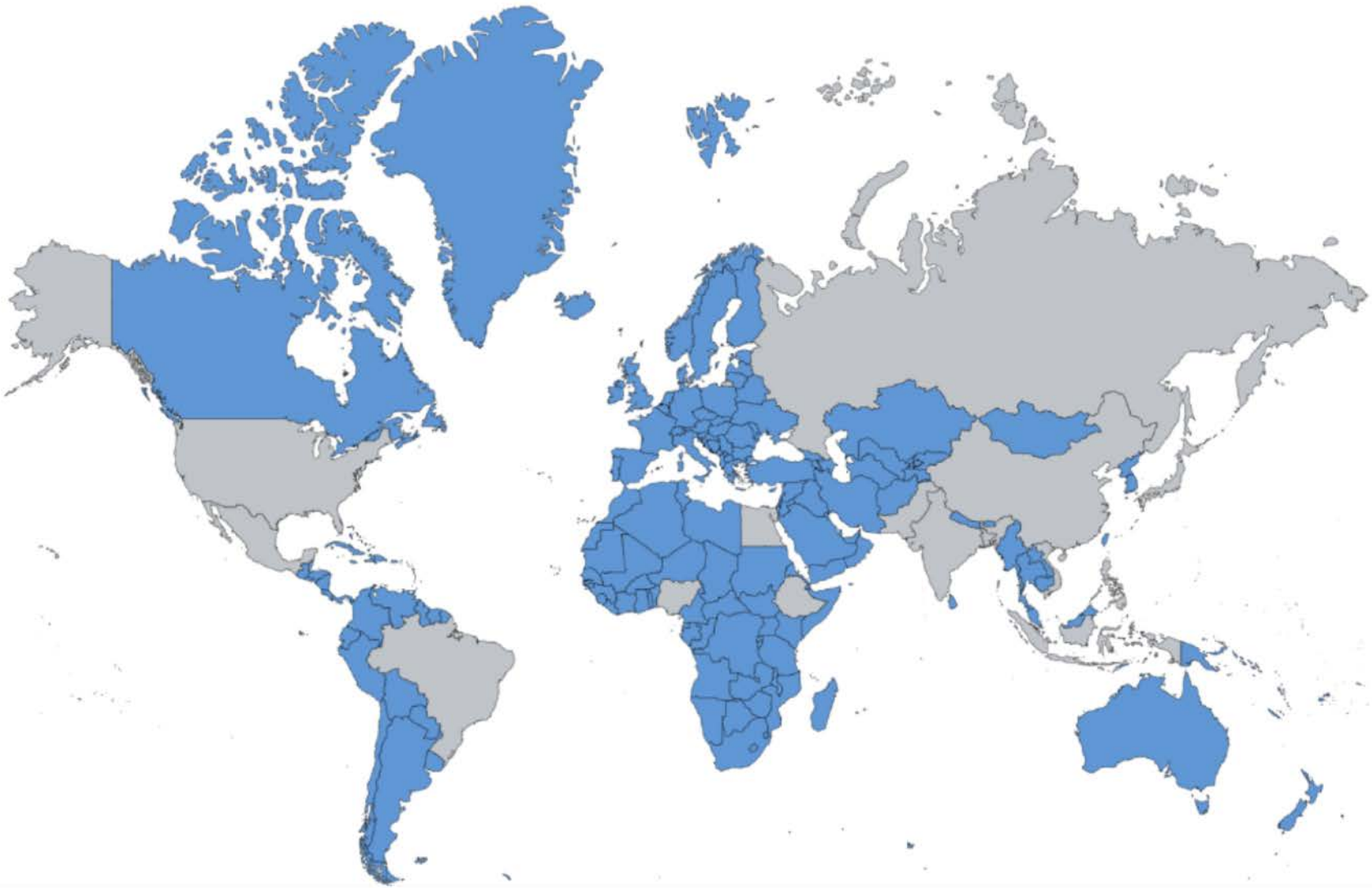
More rapid urbanization is occurring in low-income regions

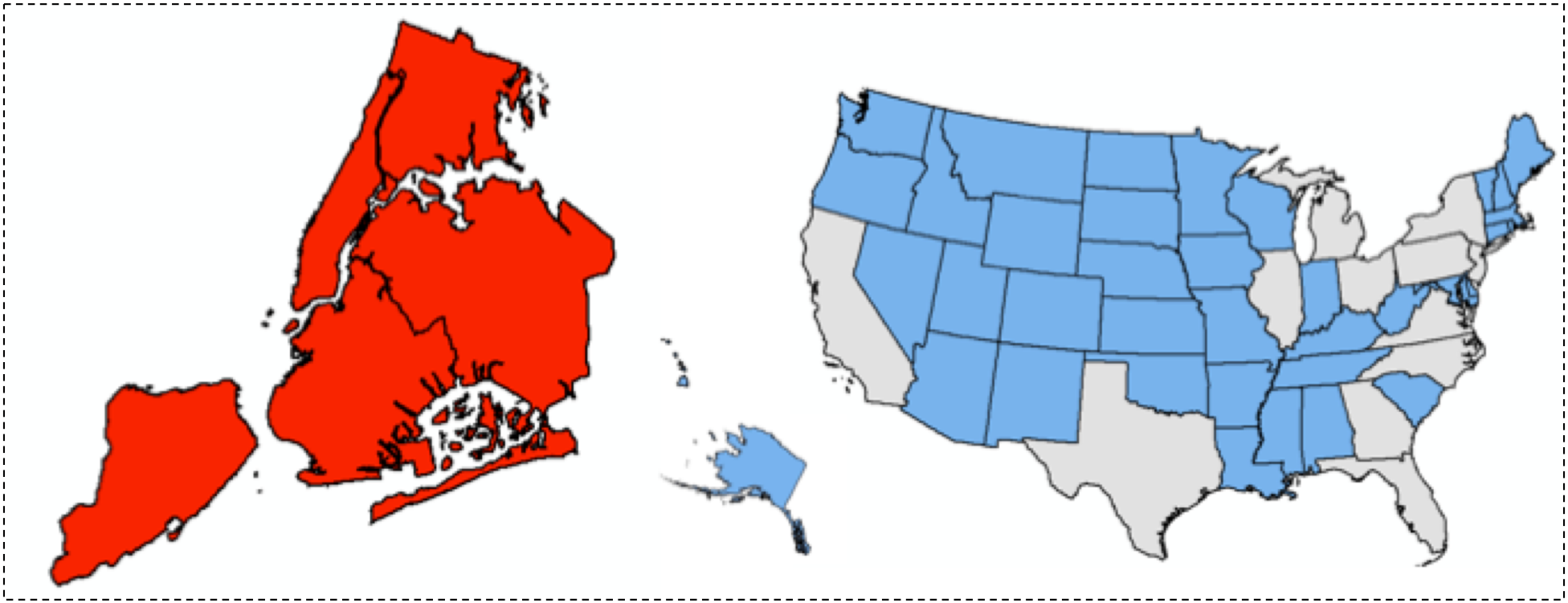


United Nations Human Settlements Programme. The challenge of slums : global report on human settlements, 2003. Earthscan Publications: London. 2003

The total population of the ten largest cities in the world…

…is larger than all but the15 largest countries in the world





The Gross Metropolitan Product of the top 10 metro areas in the U.S. in 2012 exceeded the combined output of 36 states

Total Gross Metro Product:
$5.34 trillion

- New York-Northern New Jersey-Long Island, NY-NJ-PA
- Los Angeles-Long Beach-Santa Ana, CA
- Chicago-Joliet-Naperville, IL-IN-WI
- Houston-Sugar Land-Baytown, TX
- Washington-Arlington-Alexandria, DC-VA-MD-WV
- Dallas-Fort Worth-Arlington, TX
- Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
- San Francisco-Oakland-Fremont, CA
- Boston-Cambridge-Quincy, MA-NH
- Atlanta-Sandy Springs-Marietta, GA

>

Total Gross State Product:
$5.04 trillion

- Vermont
- Wyoming
- Montana
- South Dakota
- North Dakota
- Rhode Island
- Alaska
- Maine
- Idaho
- New Hampshire
- Delaware
- West Virginia
- Hawaii
- New Mexico
- Nebraska
- Mississippi
- Arkansas
- District of Columbia
- Utah
- Nevada
- Kansas
- Iowa
- Oklahoma
- Kentucky
- South Carolina
- Alabama
- Oregon
- Connecticut
- Louisiana
- Missouri
- Wisconsin
- Arizona
- Colorado
- Tennessee
- Minnesota
- Indiana

U.S. Metro Economies: Outlook – Gross Metropolitan Product, with Metro Employment Projections. Prepared for: The United States Conference of Mayors and the Council on Metro Economies and the New American City. November 2013. <http://www.usmayors.org/metroeconomies/2013/201311-report.pdf> Accessed October 22, 2014.

Ten most populated urban areas in the world

All cities in the world occupy about 1% of the world's land surface, and >50% of the people

https://www.quora.com/What-are-some-great-interesting-facts-about-different-cities-all-over-the-world

The heterogeneity of urban spaces

Boston T-stops

Percent of adults with diabetes by T stop, 2010

If you get off at Arlington: 3%

If you get off at Fenway: 2%

If you get off at Maverick: 11%

If you get off at Dudley Square: 11%

If you get off at Mattapan: 10%

Health of Boston 2012-2013: A neighborhood focus. Boston Public Health Commission. <http://www.bphc.org/healthdata/health-of-boston-report/Pages/Health-of-Boston-Report.aspx> Accessed February 9, 2015.

Percent of residents 25+years old with a bachelors degree or more by T stop, 2006-2010

If you get off at Arlington: 79%

If you get off at Fenway: 71%

If you get off at Maverick: 16%

If you get off at Dudley Square: 25%

If you get off at Mattapan: 16%

Health of Boston 2012-2013: A neighborhood focus. Boston Public Health Commission. <http://www.bphc.org/healthdata/health-of-boston-report/Pages/Health-of-Boston-Report.aspx> Accessed February 9, 2015.

Percent of adults who get regular physical activity by T stop, 2010

If you get off at Arlington: 68%

If you get off at Fenway: 68%

If you get off at Maverick: 48%

If you get off at Dudley Square: 51%

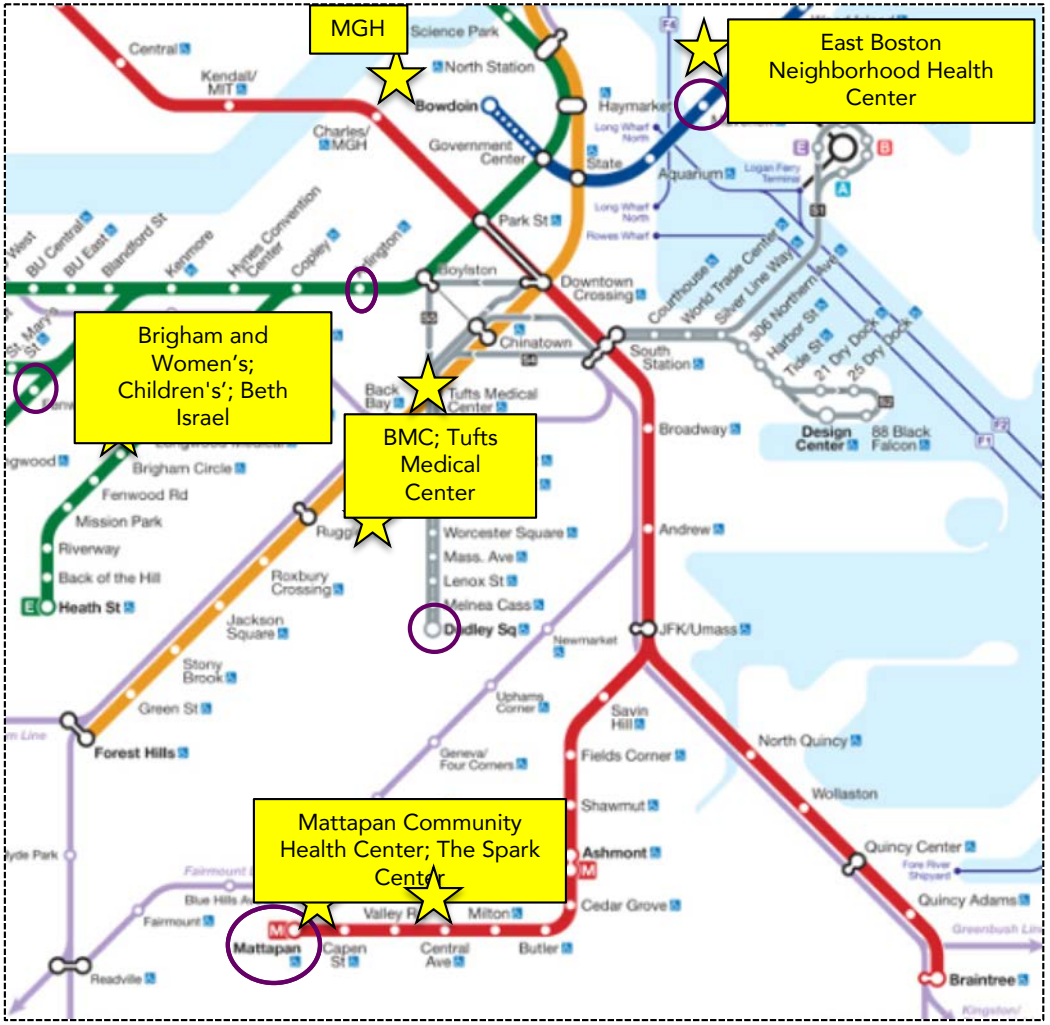
If you get off at Mattapan: 50%

Health of Boston 2012-2013: A neighborhood focus. Boston Public Health Commission. <http://www.bphc.org/healthdata/health-of-boston-report/Pages/Health-of-Boston-Report.aspx> Accessed February 9, 2015.

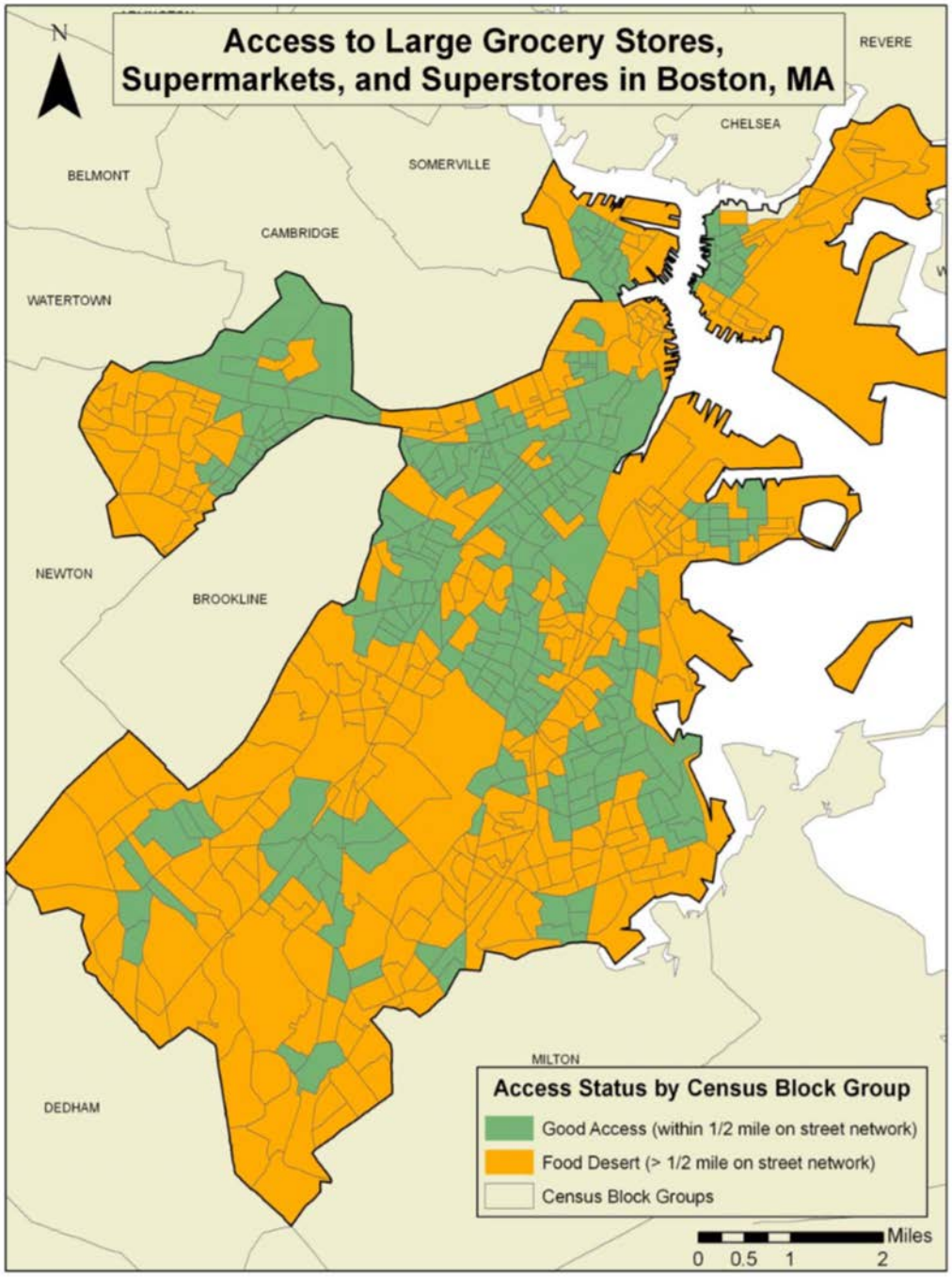
…despite the fact that the geographic distance between these areas is so small…

Google Maps. <https://www.google.com/maps/> Accessed March 17, 2015.

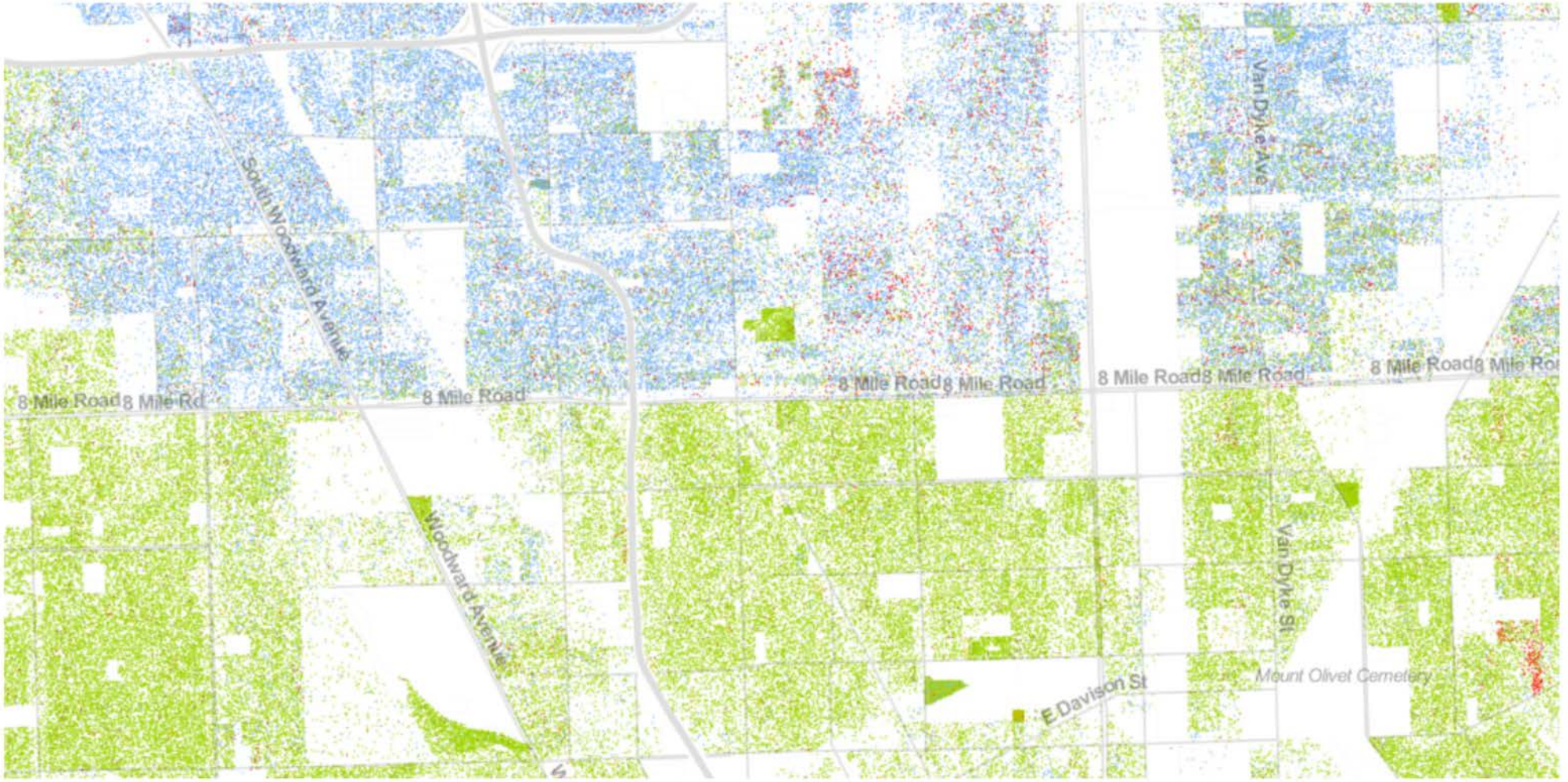
…and despite the fact that they do not differ greatly on geographic closeness to health services



Google Maps. <https://www.google.com/maps/> Accessed March 17, 2015.



http://sites.tufts.edu/gis/files/2013/02/Lawrence_Kelly.pdf



In Detroit, amongst the most segregated cities in America, 8 Mile Road serves as a sharp racial dividing line.
Image: Dustin Cable

http://www.wired.com/2013/08/how-segregated-is-your-city-this-eye-opening-map-shows-you/

Understanding cities and health

FIGURE 1. The power of the prevailing paradigm: drawing of an Australian kangaroo by a sixteenth-century Dutch artist (Cornelis de Jode), based on descriptions by early explorers.

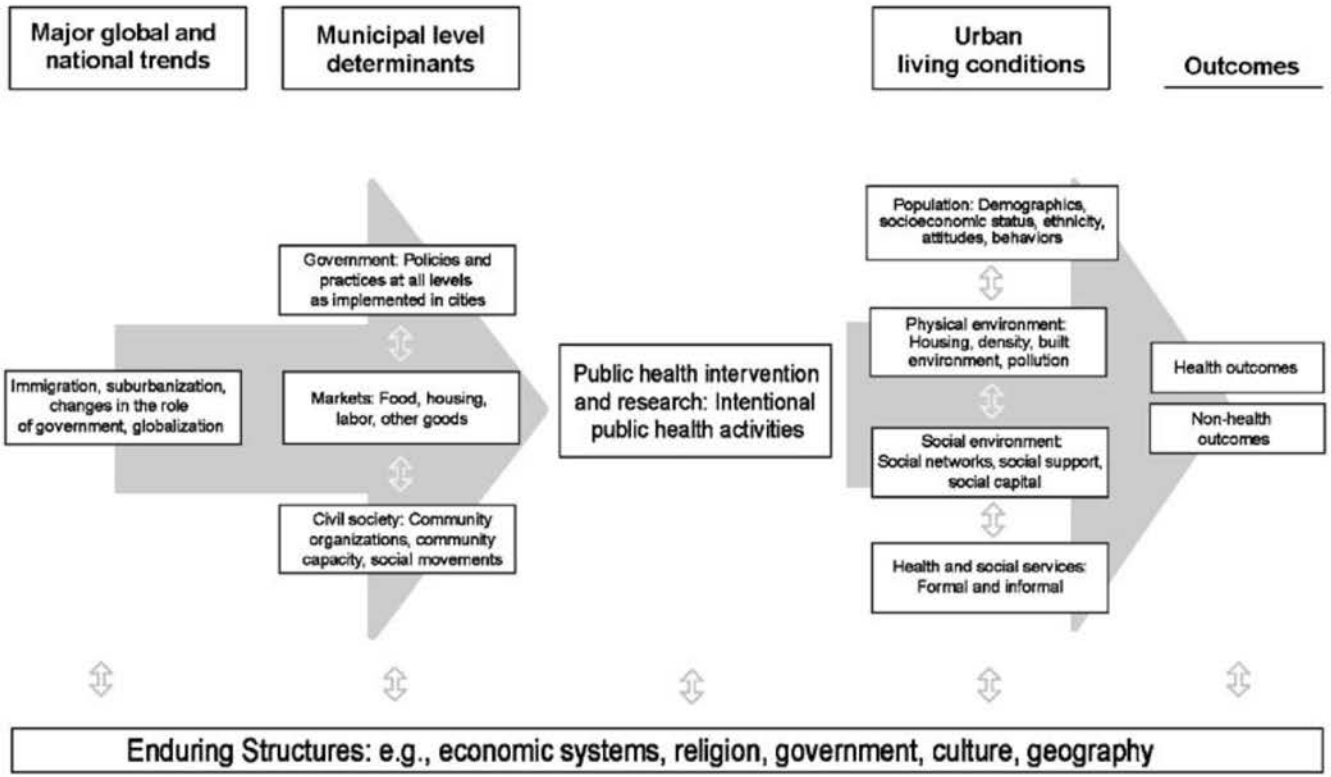
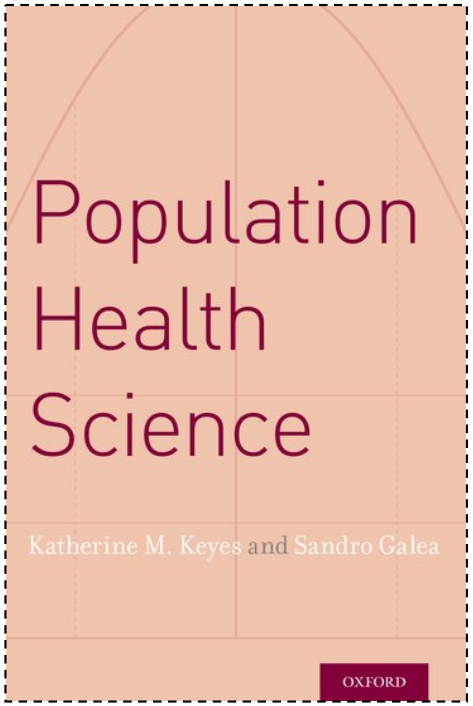


Fig. 1. A conceptual framework for Urban Health. Because of the complexity of the potential relations among the determinants of health of urban populations, our framework of necessity simplifies a number of potential relations between the domains shown here and discussed in the manuscript. A more detailed description of some of the plausible relations between key variables in the conceptual framework is provided in the text. We also note that the arrows in the figure are purely schematic and do not mean to be exhaustive or definitive. There are several interrelationships between the domains presented here and we would anticipate that most relationships would be multidirectional. This pictorial representation of the framework discussed in the text also is limited by its static nature. A fuller depiction of the determinants of the health of urban populations would incorporate the changes over time (e.g., growing city population) that in and of themselves are important determinants of health.

Galea S, Freudenberg N, Vlahov D. Cities and population health. Social Science & Medicine 2005;60(5):1017-1033. PMID: 15589671.
http://dx.doi.org/10.1016/j.socscimed.2004.06.036

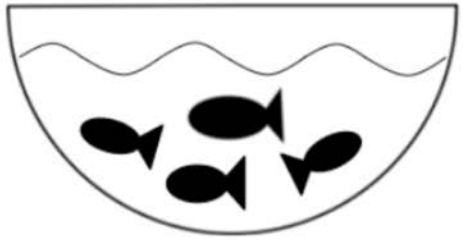


“Population health science is the study of the conditions that shape distributions of health within and across populations, and of the mechanisms through which these conditions manifest as the health of individuals”

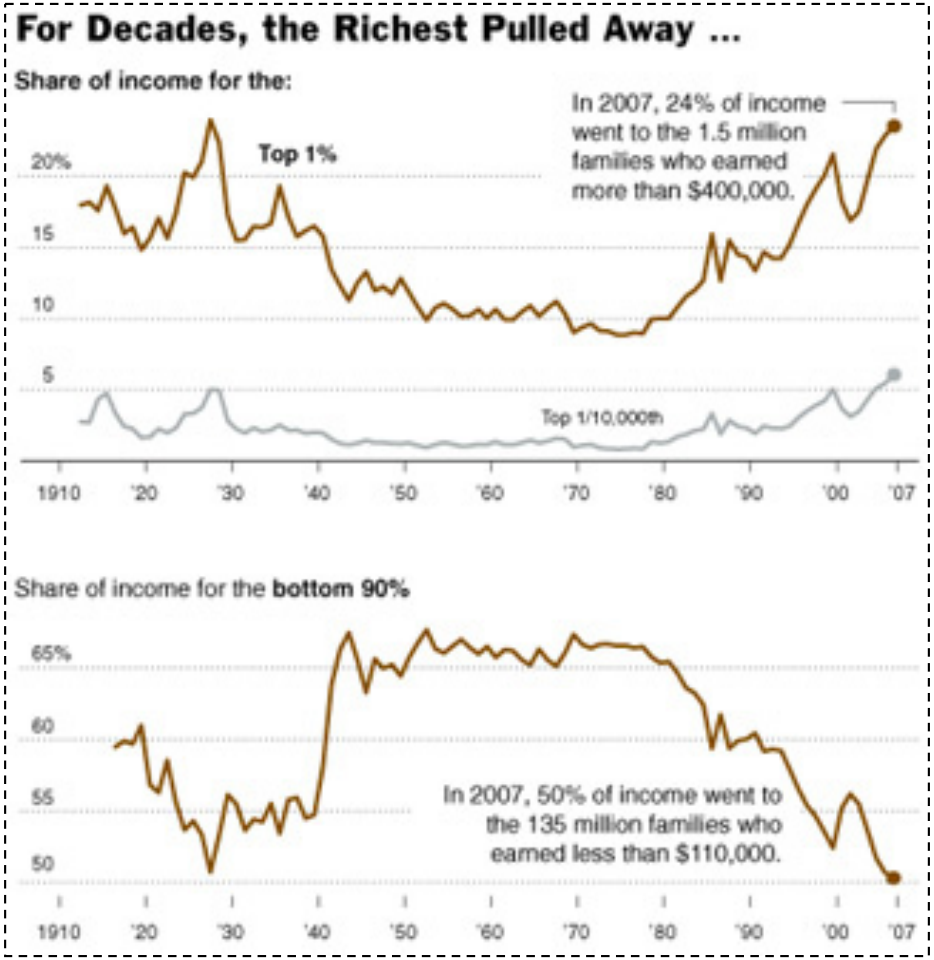
1. Population health manifests as a continuum.
2. The causes of differences in health across populations are not necessarily an aggregate of the causes of differences in health within populations.
3. Large benefits to population health may not improve the lives of all individuals.
4. The causes of population health are multilevel, accumulate throughout the life course, and are embedded in dynamic interpersonal relationships.
5. Small changes in ubiquitous causes may result in more substantial change in the health of populations than larger changes in rarer causes.
6. The magnitude of an effect of exposure on disease is dependent on the prevalence of the factors that interact with that exposure.
7. Prevention of disease often yields a greater return on investment than curing disease after it has started.
8. Efforts to improve overall population health may be a disadvantage to some groups; whether equity or efficiency is preferable is a matter of values.
9. We can predict health in populations with much more certainty than we can predict health in individuals.

Principle 5. Small changes in ubiquitous causes may result in more substantial change in the health of populations than larger changes in rarer causes

Figure 1. A metaphor for ubiquity



The goldfish are surrounded by water and everything they do is influenced by the quality of the water in which they live; therefore, water is a ubiquitous factor influencing the fish and needs to be taken into consideration every time we may want to improve the lives of the fish.



http://farm3.static.flickr.com/2499/4056337199_a4620eb2ea.jpg

Table 1. Five-year mortality for those 18-65 in country with high income inequality

	# died	# alive	total
IV drug user	50	950	1000
Non-IV drug user	400	49600	50000
Total	450	50550	51000

$$\mathrm{RR} = \frac{\frac{50}{1000}}{\frac{400}{50{,}000}} = 6.25$$

$$\mathrm{RD} = \left(\frac{50}{1000}\right) - \left(\frac{400}{50{,}000}\right) = 0.042$$

The prevalence of IV drug use is 1.96% and IV drug users have 6.25 times the risk of mortality compared with non-IV drug users. For every 100 IV drug users, we would expect 4.2 additional deaths.

Suppose we reduce income inequality by 25%, keeping prevalence of IV drug use the same, but reducing excess mortality in all groups

Table 2. Five-year mortality for those 18-65 after reduction in income inequality

	# died	# alive	total
IV drug user	40	960	1000
Non-IV drug user	320	49680	50000
	360	50640	51000

Table 3. Comparison of 5-year mortality for those 18-65 before and after change in income inequality

	# died	# alive	Total
Before change in income inequality	450	50550	51000
After change in income inequality	360	50640	51000

$$RR = \frac{\frac{450}{51000}}{\frac{360}{51000}} = 1.25$$

$$RD = \left(\frac{450}{51000}\right) - \left(\frac{360}{51000}\right) = 0.0018$$

Therefore, those in the unequal society had 1.25 times the risk of death, and we would expect 1.8 deaths per 1,000 persons exposed to the unequal society

In the hypothetical income inequality intervention, we have “saved” 90 lives.
In our IV drug use example, we would “save” a maximum of 42 lives even if all IV drug users stopped using.

Crack Babies: The Worst Threat Is Mom Herself

By Douglas J. Besharov

LAST WEEK in this city, Greater Southeast Community Hospital released a 7-week-old baby to her homeless, drug-addicted mother even though the child was at severe risk of pulmonary arrest. The hospital's explanation: "Because [the mother] demanded that the baby be released."

The hospital provided the mother with an apnea monitor to warn her if the baby stopped breathing while asleep, and trained her in CPR. But on the very first night, the mother went out drinking and left the child at a friend's house—without the monitor. Within seven hours, the baby was dead. Like Dooney Waters, the 6-year-old living in his mother's drug den, whose shocking story was reported in The Washington Post last week, this child was all but abandoned by ities.

September 17, 1989

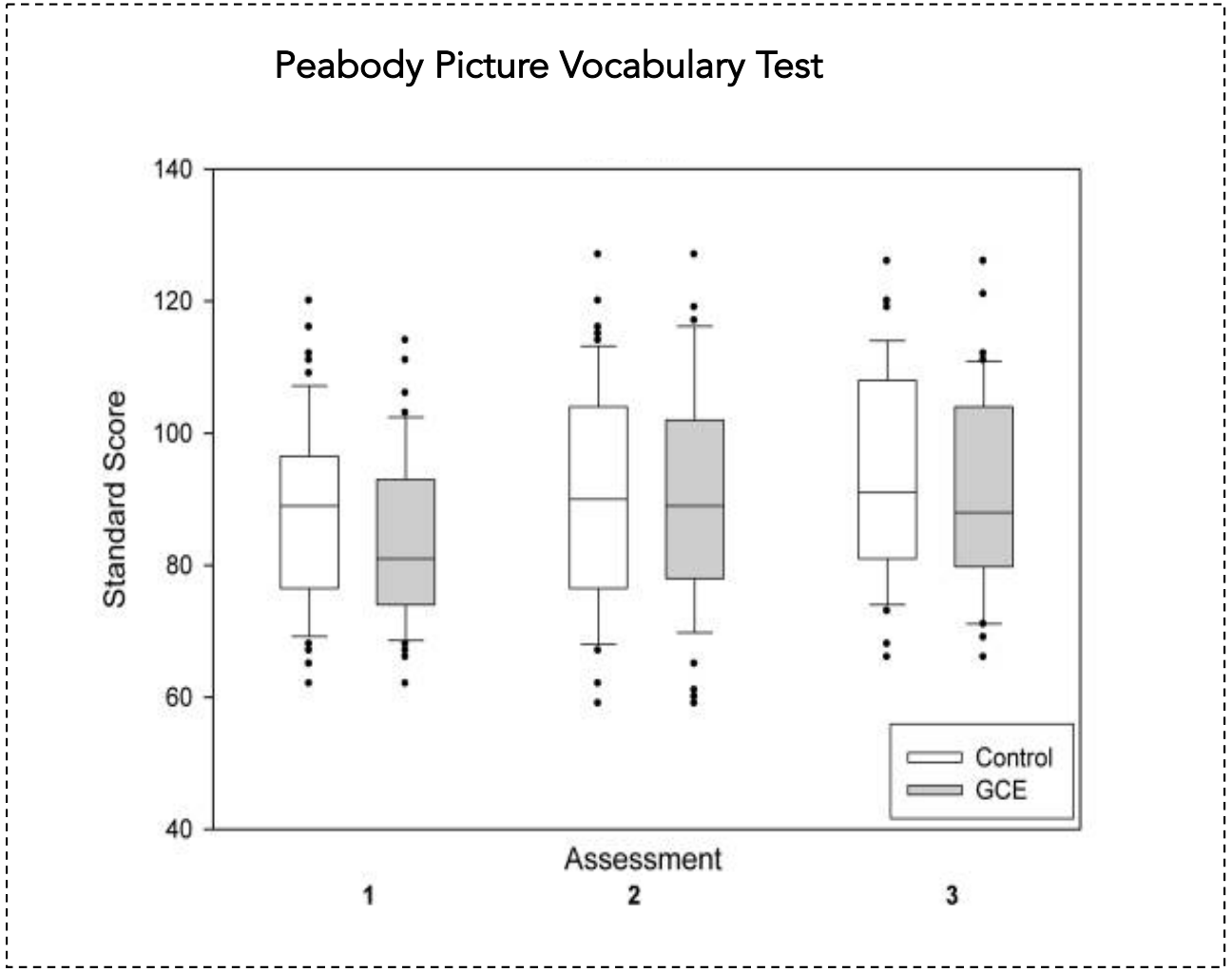
Crack's Toll Among Babies: A Joyless View

September 6, 1988

Cocaine: Litany of Fetal Risks Grows

CHILDREN OF COCAINE

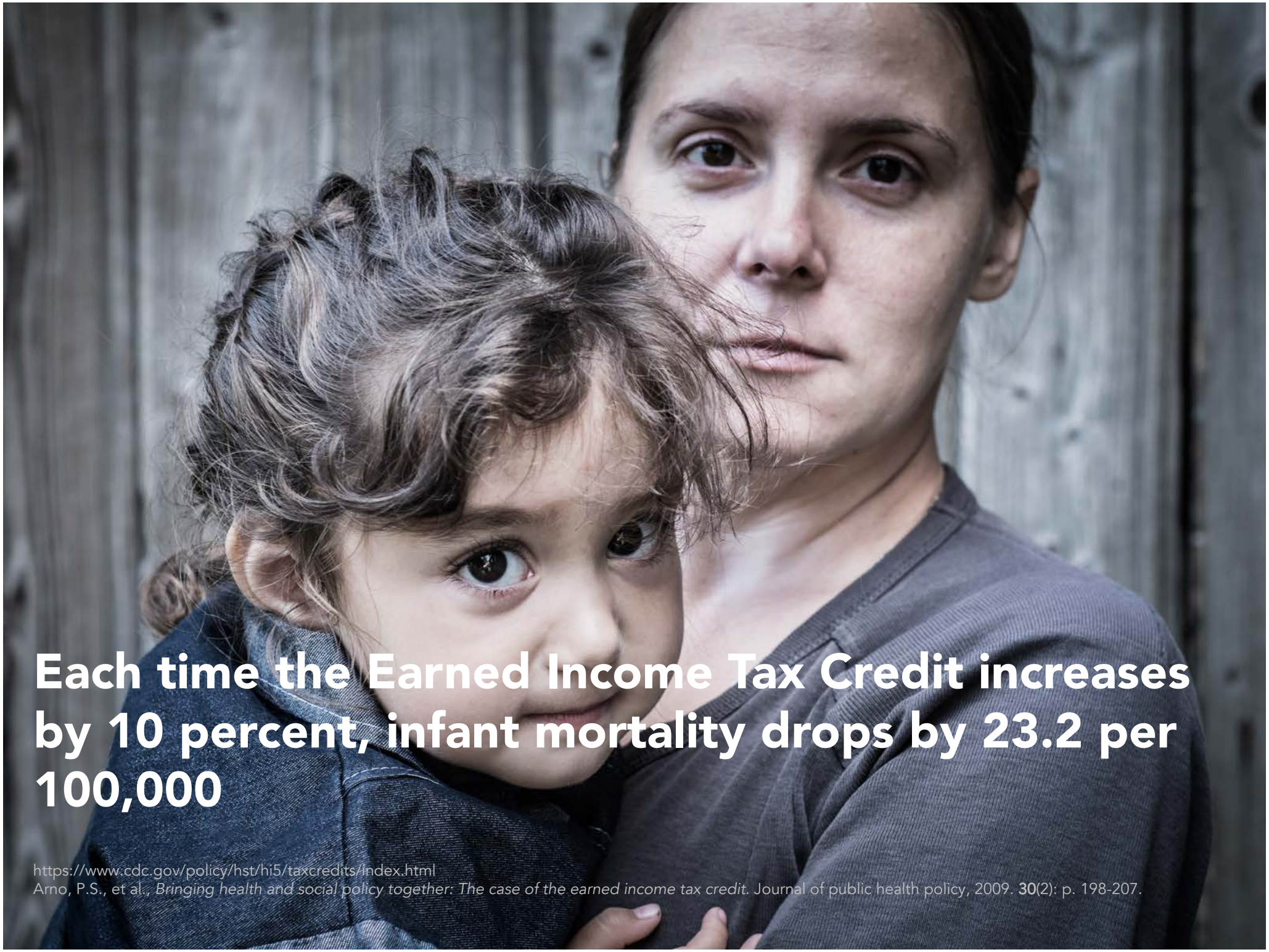
(By Charles Krauthammer)



Betancourt LM et al. Adolescents with and without gestational cocaine exposure: Longitudinal analysis of inhibitory control, memory and receptive language. *Neurotoxicol Teratol* 2011; 33(1): 36-46.

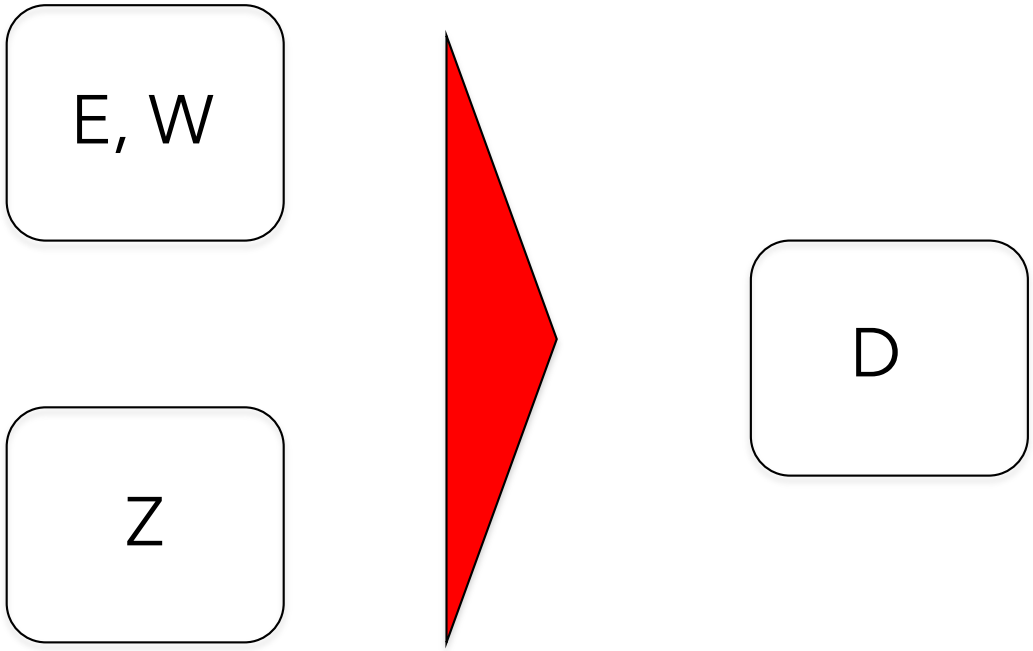
Predictor for Peabody Picture Vocabulary Test score	Coefficient	P-value
Gestational cocaine exposure	-2.89	0.26
Assessment no.	2.72	<0.001
Gestational cocaine exposure x assessment no.	0.58	0.51
Age at 1st assessment	-0.36	0.76
Female gender	-4.93	0.058
Parental nurturance	-0.31	0.89
Environmental stimulation	5.91	0.039
Caregiver BDI-II depression score	0.03	0.84

Betancourt LM et al. Adolescents with and without gestational cocaine exposure: Longitudinal analysis of inhibitory control, memory and receptive language. *Neurotoxicol Teratol* 2011; 33(1): 36-46.



https://www.cdc.gov/policy/hst/hi5/taxcredits/index.html
Arno, P.S., et al., *Bringing health and social policy together: The case of the earned income tax credit.* Journal of public health policy, 2009. **30**(2): p. 198-207.

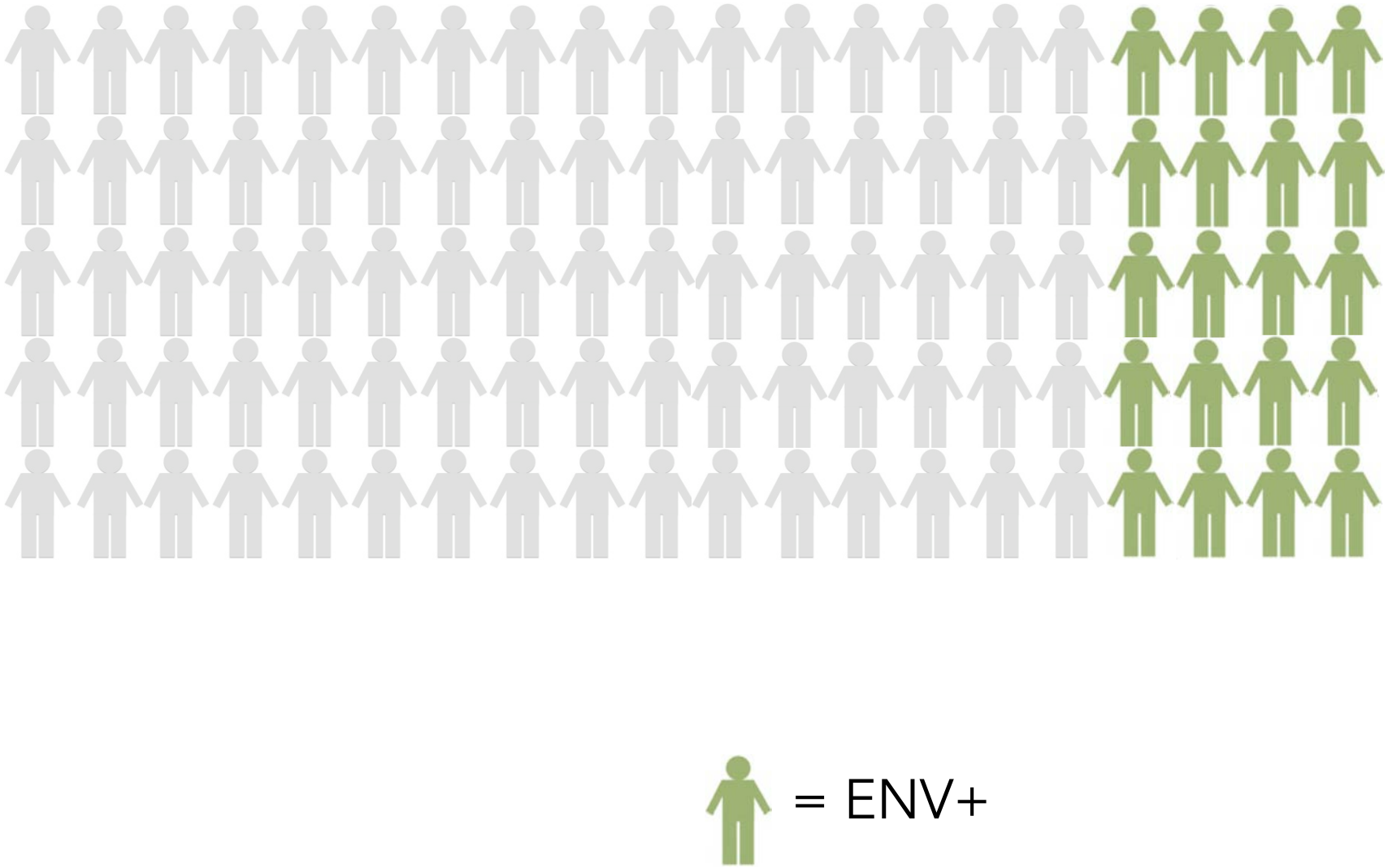
Principle 6. The magnitude of an effect of exposure on disease is dependent on the prevalence of the factors that interact with that exposure


E, W
Z
D

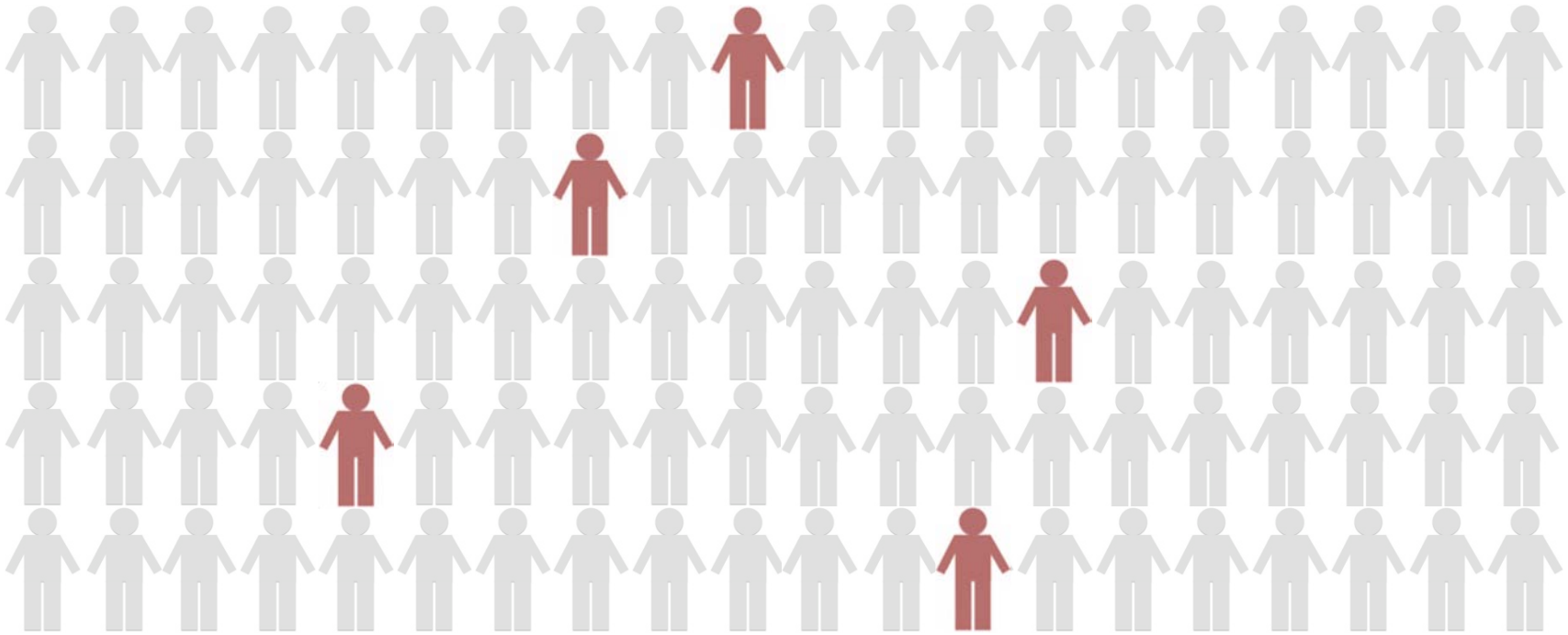
How much of our obesity risk is determined by our genes?

 = GE+

GE = genetic



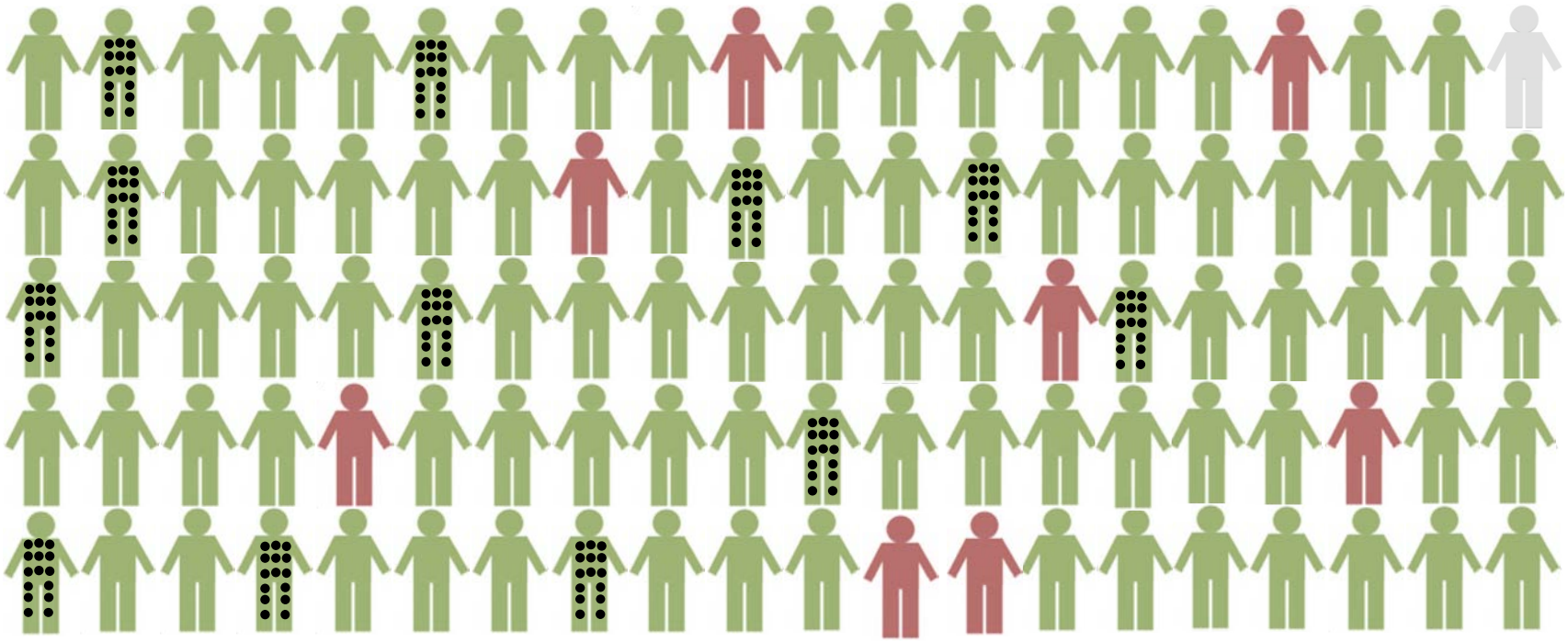
ENV = environmental



= OB+

OB = obese

Scenario 1



= GE+ = OB+ = ENV+

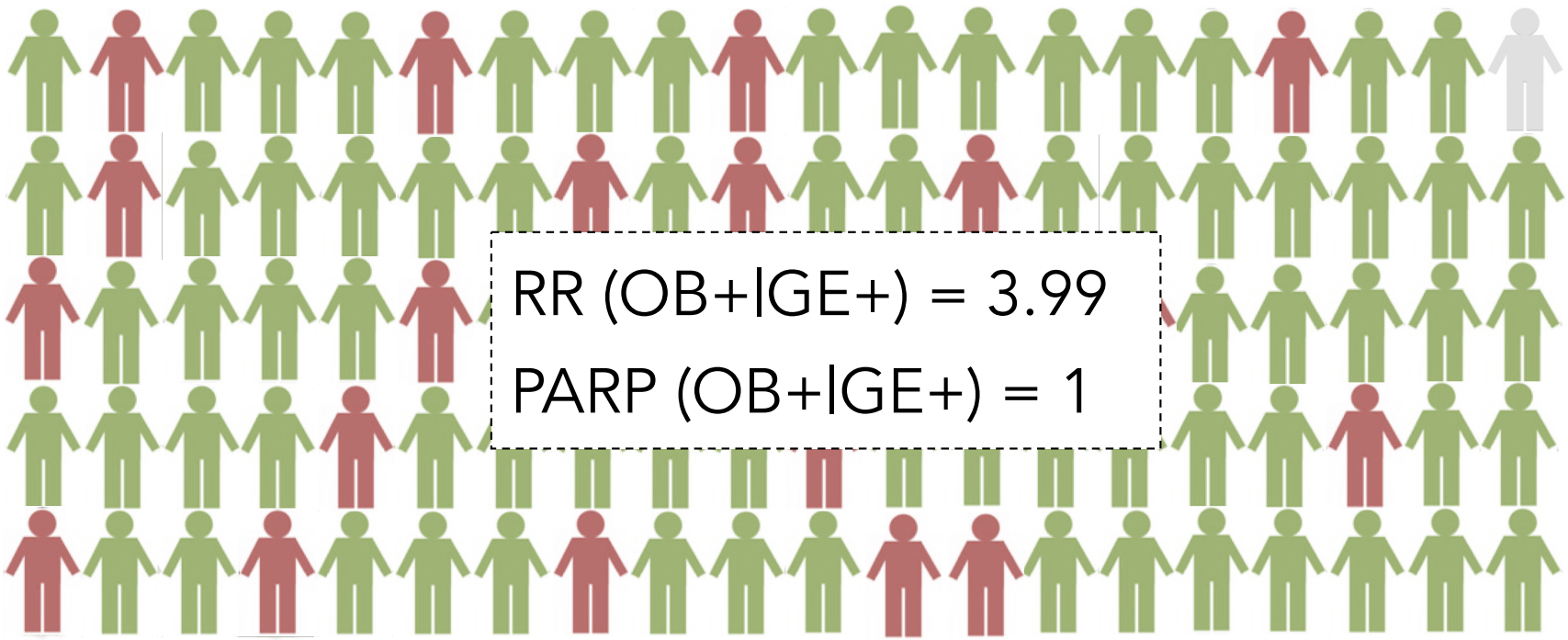
GE = genetic; OB = obese; ENV = environmental

Scenario 1

= GE+ = OB+ = ENV+

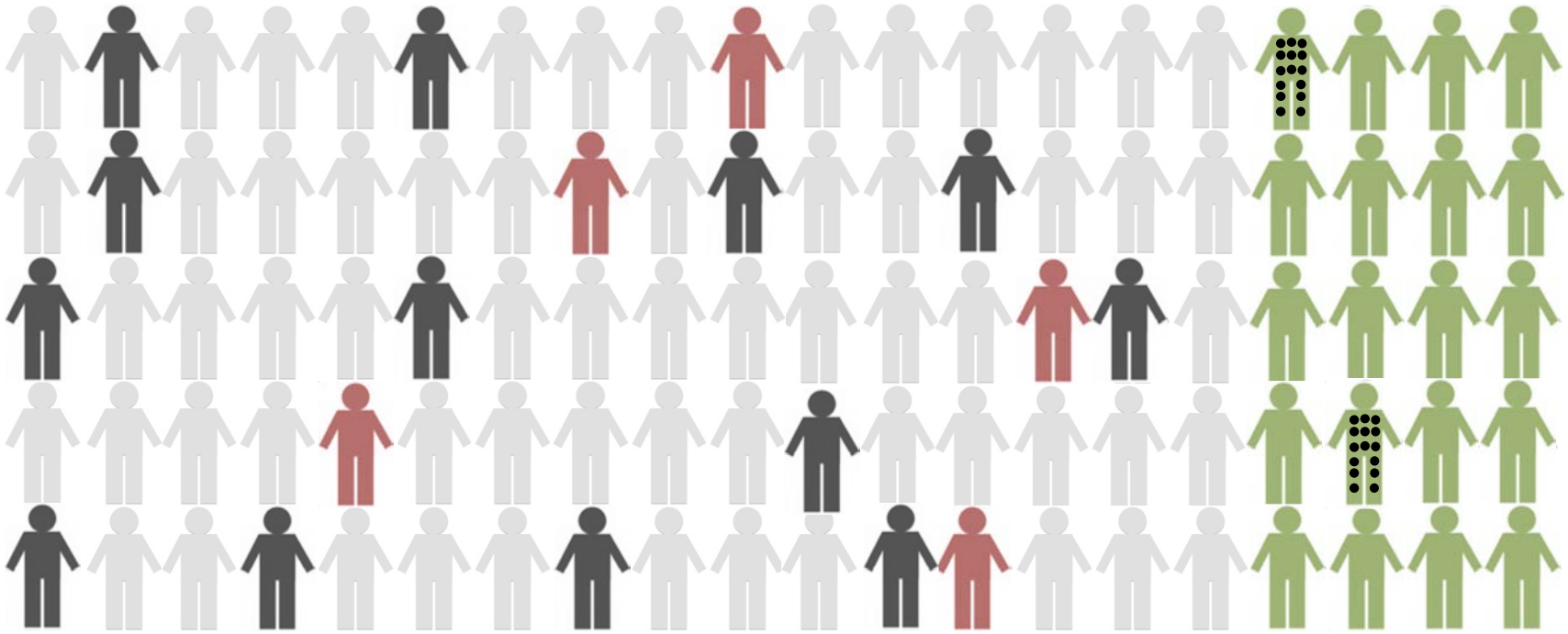
GE = genetic; OB = obese; ENV = environmental

Scenario 1



= GE+ = CA+ = ENV+

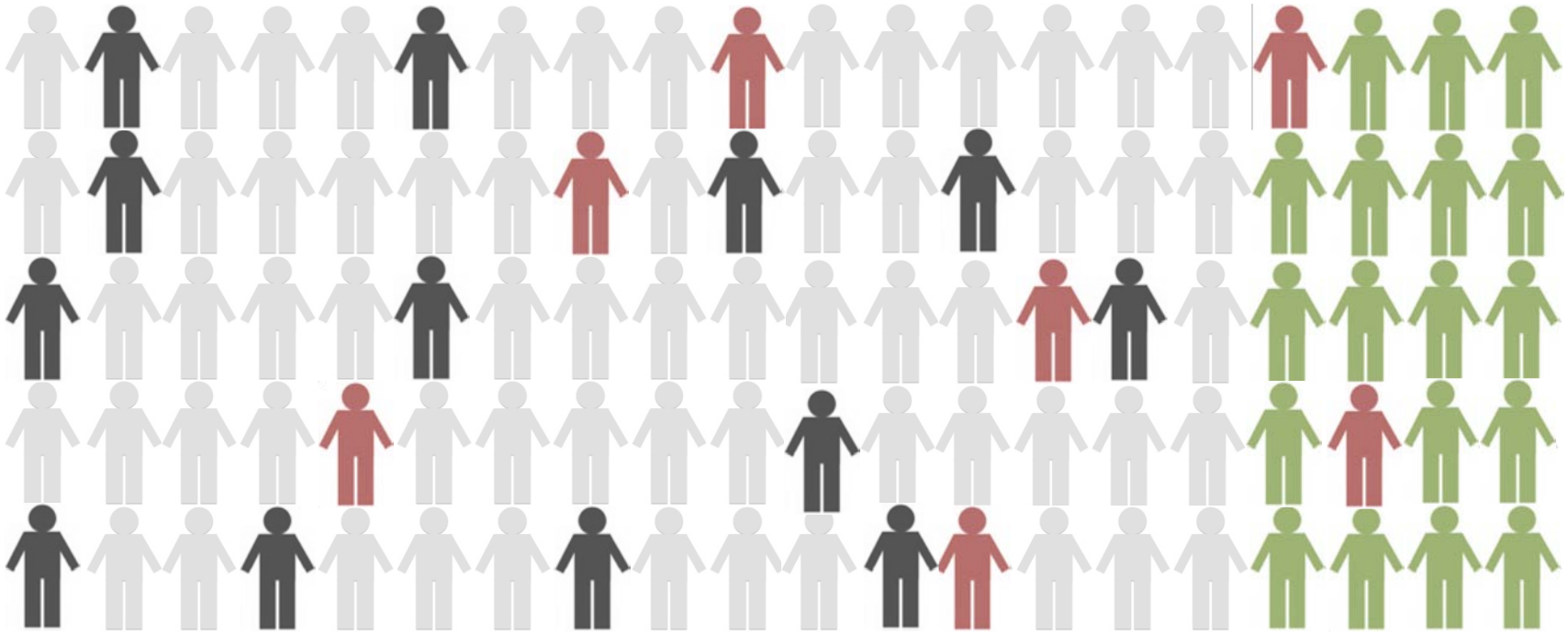
Scenario 2



= GE+ = OB+ = ENV+

GE = genetic; OB = obese; ENV = environmental

Scenario 2



= GE+ = OB+ = ENV+

GE = genetic; OB = obese; ENV = environmental

Scenario 2

= GE+ = OB+ = ENV+

Therefore under a very plausible assumption of co-occurring causes, the gene-obesity association can only be understood if we understand the urban factors that distinguish between samples

Is this all theoretical?

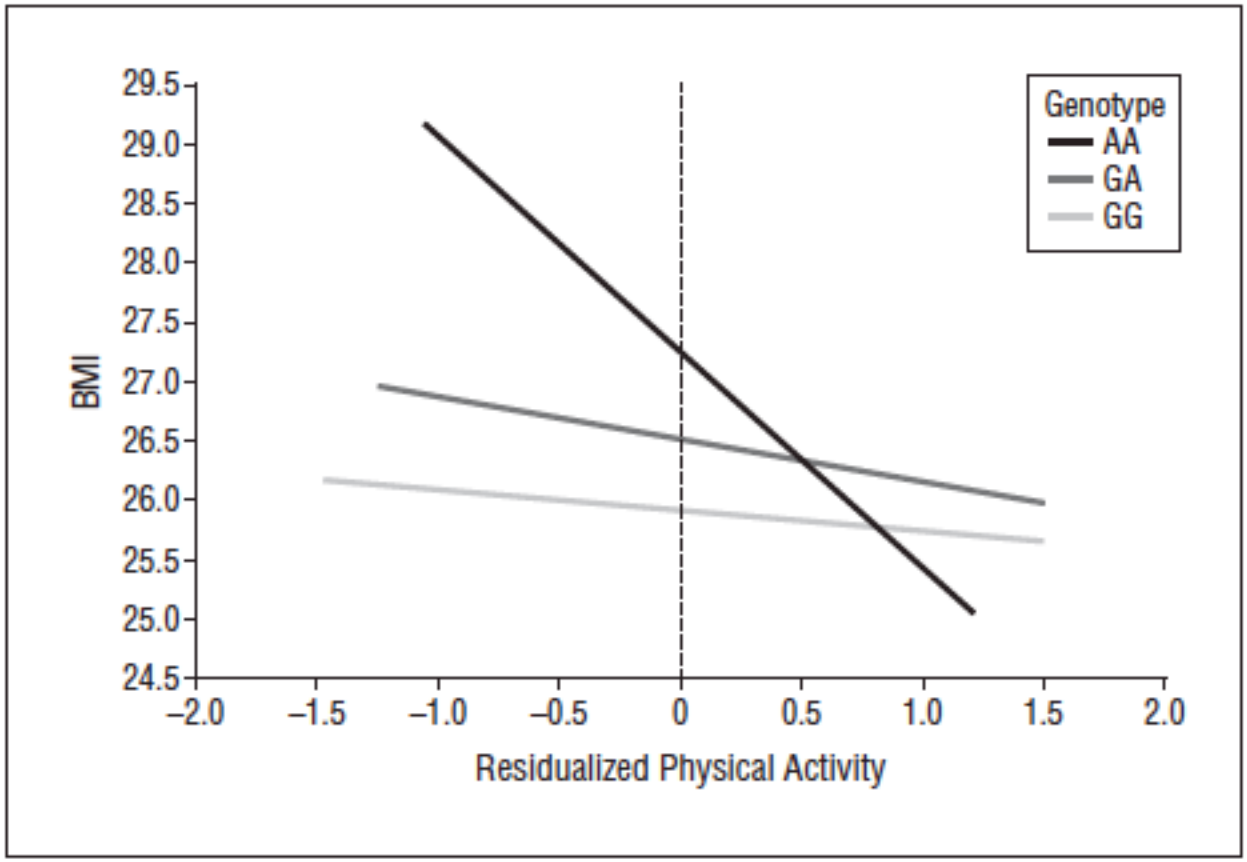


Figure 3. Predicted body mass index (BMI), calculated as weight in kilograms divided by height in meters squared, as a function of residualized age- and sex-specific ln-transformed physical activity accelerometer counts according to *FTO* rs1861868 genotypes. On the left side of the plot (low physical activity), BMI levels are strikingly dissimilar between rs1861868 genotypes. In contrast, on the right side of the plot, similar BMI levels can be seen across genotypes, particularly in subjects with very high levels of physical activity.

Rampersaud E, Mitchell BD, Pollin TI, Fu M, Shen H, O'Connell JR, et al. Physical Activity and the Association of Common FTO Gene Variants With Body Mass Index and Obesity. *Arch Intern Med*. 2008;168(16):1791-1797.

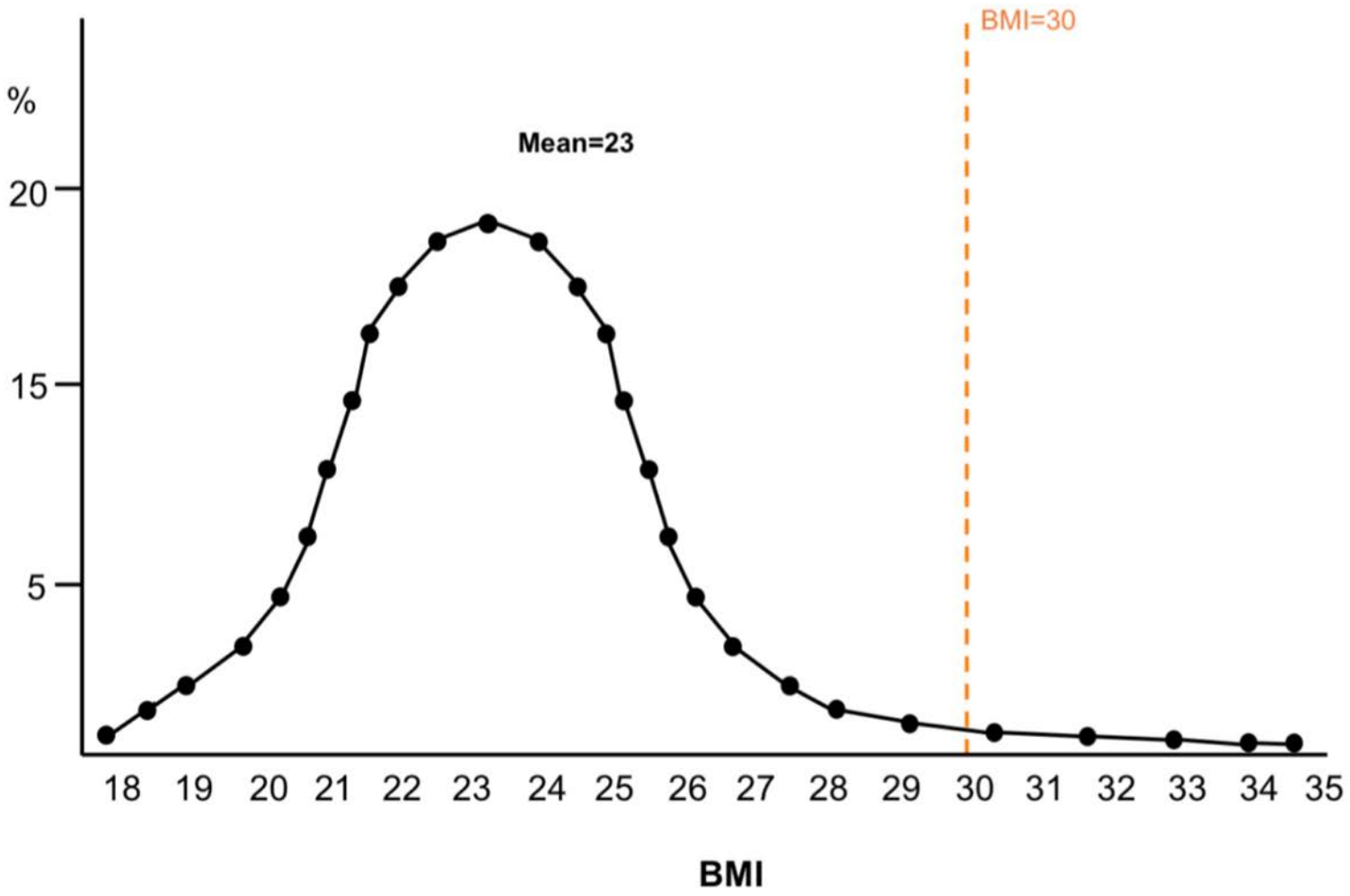
Financial support for habitable homes: After rehabilitating housing 62% of adults have excellent health vs 33% before

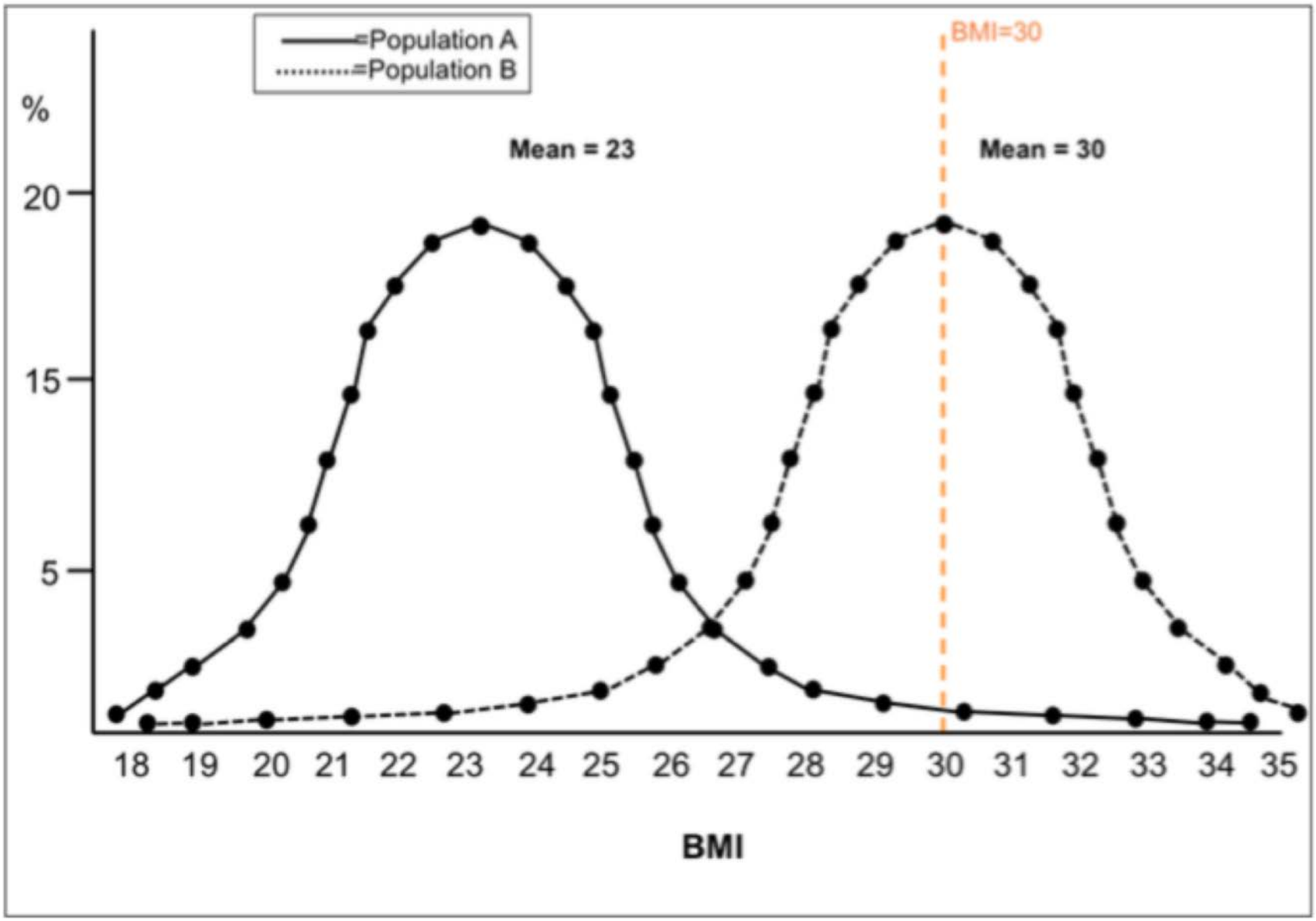
https://www.cdc.gov/policy/hst/hi5/homeimprovement/index.html ; Breysse J et al. Health Outcomes and Green Renovation of Affordable Housing. Public Health Rep. 2011; 126(Suppl 1): 64–75. doi: 10.1177/00333549111260S110
https://www.flickr.com/photos/nodding_pig/15588502903/sizes/l

Principle 1. Population health manifests as a continuum

Figure 1. Distribution of BMI in two populations illustrating health as a continuum in the population

Panel A





BMI = body mass index

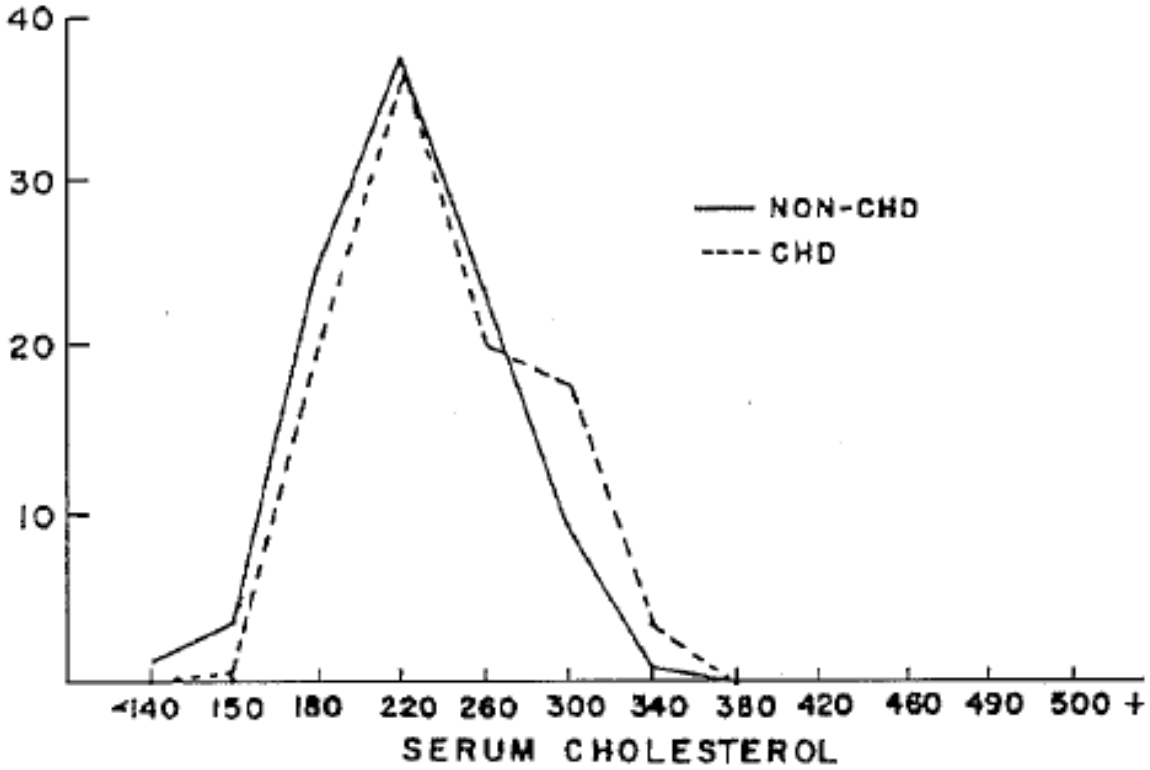
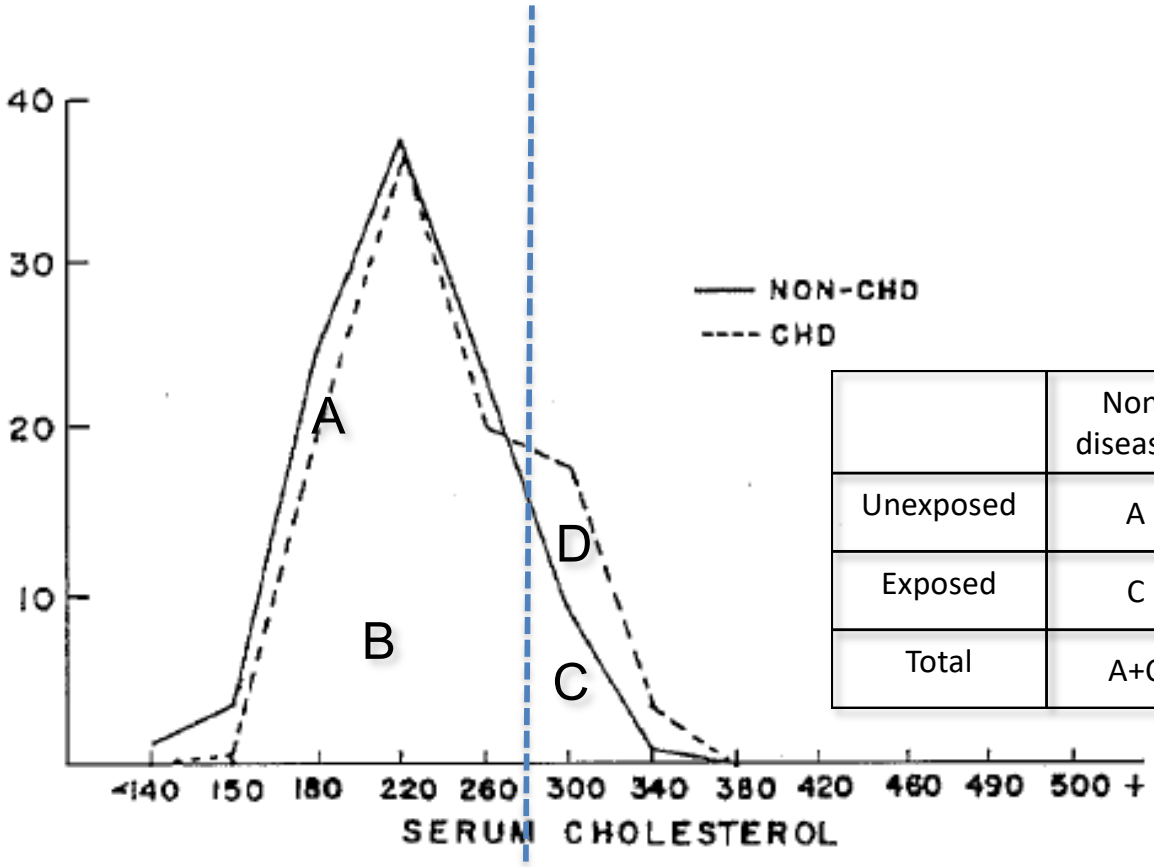


Figure 3 Percentage distribution of serum cholesterol levels (mg/dl) in men aged 50–62 who did or did not subsequently develop coronary heart disease (Framingham Study[5])

CHD = coronary heart disease



	Non-diseased	Diseased	Total
Unexposed	A	B	A+B
Exposed	C	D	C+D
Total	A+C	B+D	N

Figure 3 Percentage distribution of serum cholesterol levels (mg/dl) in men aged 50–62 who did or did not subsequently develop coronary heart disease (Framingham Study[5])

Rose G. Sick individuals and sick populations. International Journal of Epidemiology. 1985;14:32-38

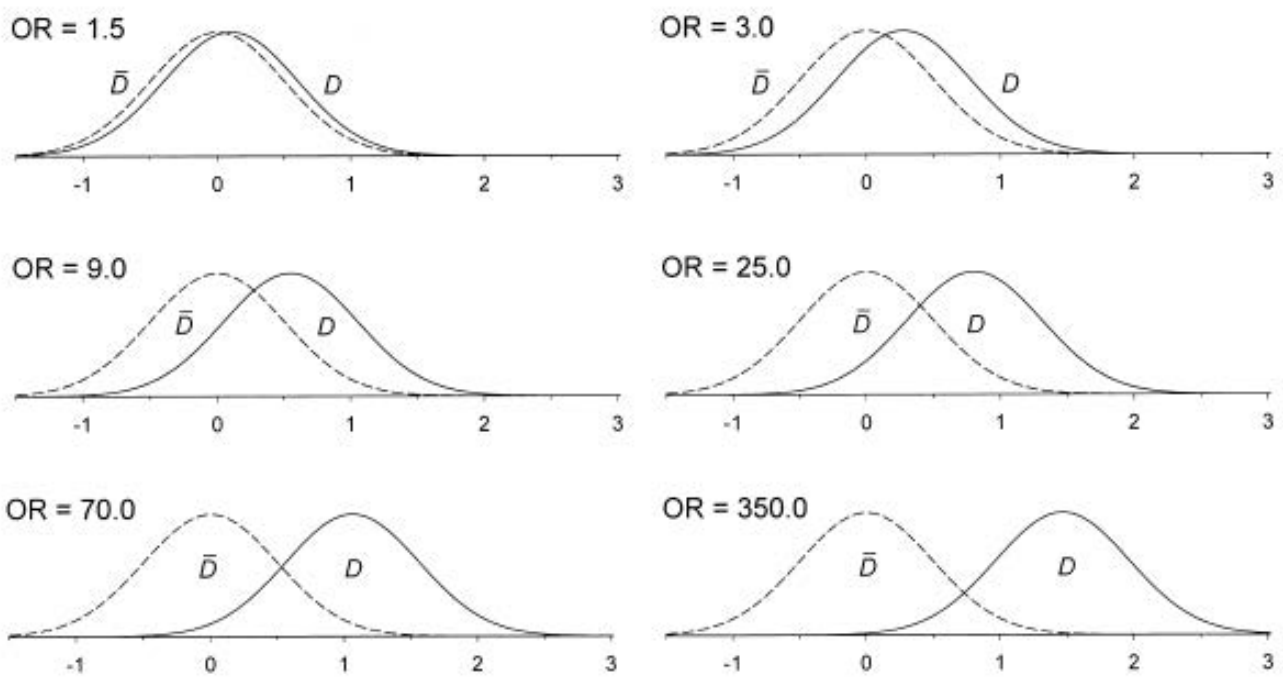


FIGURE 2. Probability distributions of a marker, X, in cases (solid curves) and controls (dashed curves) consistent with the logistic model logit$P(D = 1|X) = \alpha + \beta X$. It has been assumed that X has a mean of 0 and a standard deviation of 0.5 in controls so that a unit increase represents the difference between the 84th and 16th percentiles of X in controls. The marker is normally distributed, with the same variance in cases. The odds ratio (OR) per unit increase in X is shown.

OR = odds ratio

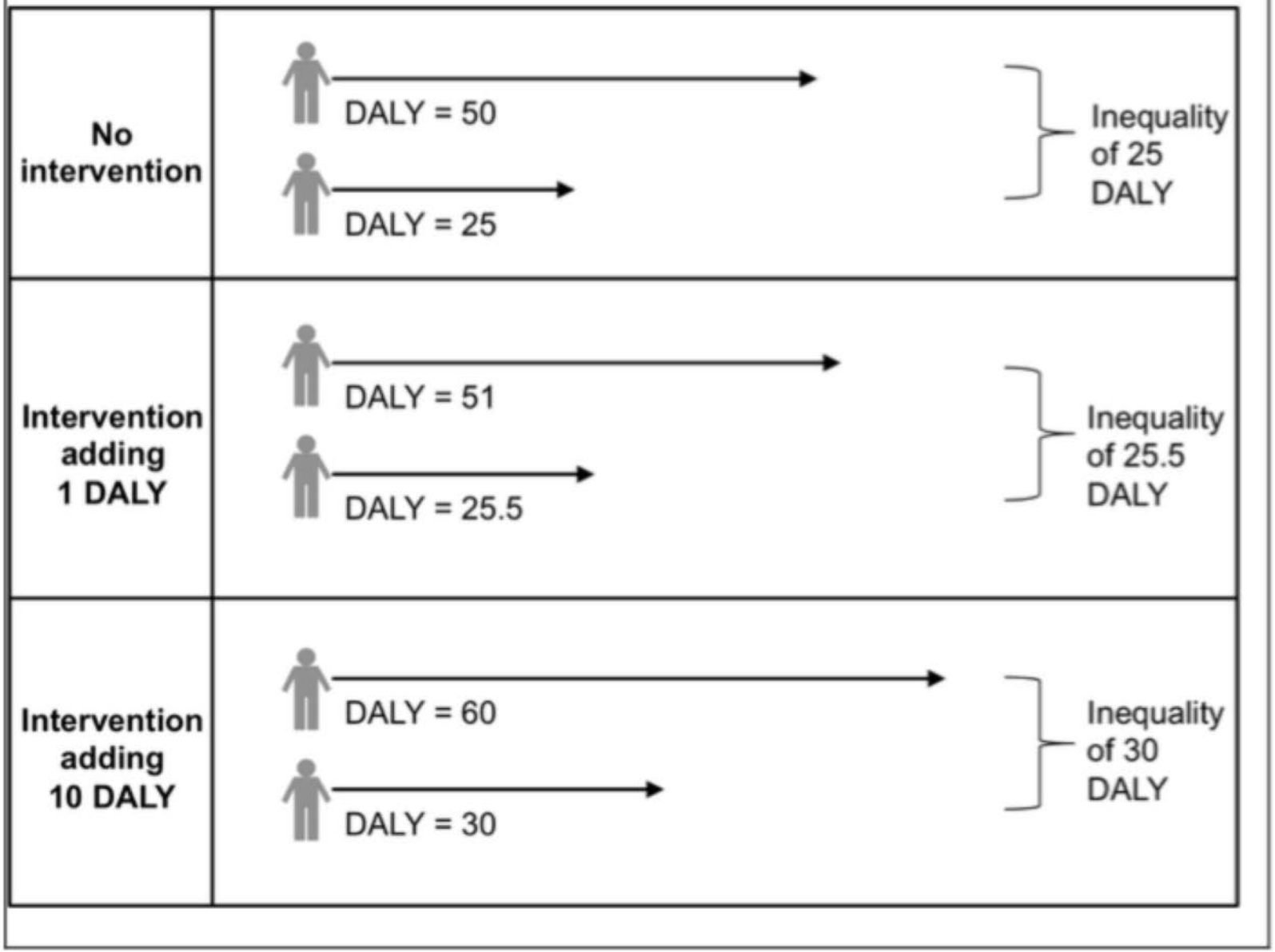
Pepe MS, Janes H, Longton G, Leisenring W, Newcomb P. Limitations of the odds ratio in gauging the performance of a diagnostic, prognostic, or screening marker. *American Journal of Epidemiology* 2004; 159:882-890.

Comprehensive workplace-based obesity prevention programs that lower weight by 5% save $90 per person.

https://www.cdc.gov/policy/hst/hi5/worksite/index.html Finkelstein, E.A., et al., *The costs of obesity in the workplace.* Journal of Occupational and Environmental Medicine, 2010. **52**(10): p. 971-976.
Trogdon, J., et al., *A return-on-investment simulation model of workplace obesity interventions.* Journal of Occupational and Environmental Medicine, 2009. **51**(7): p. 751-758.

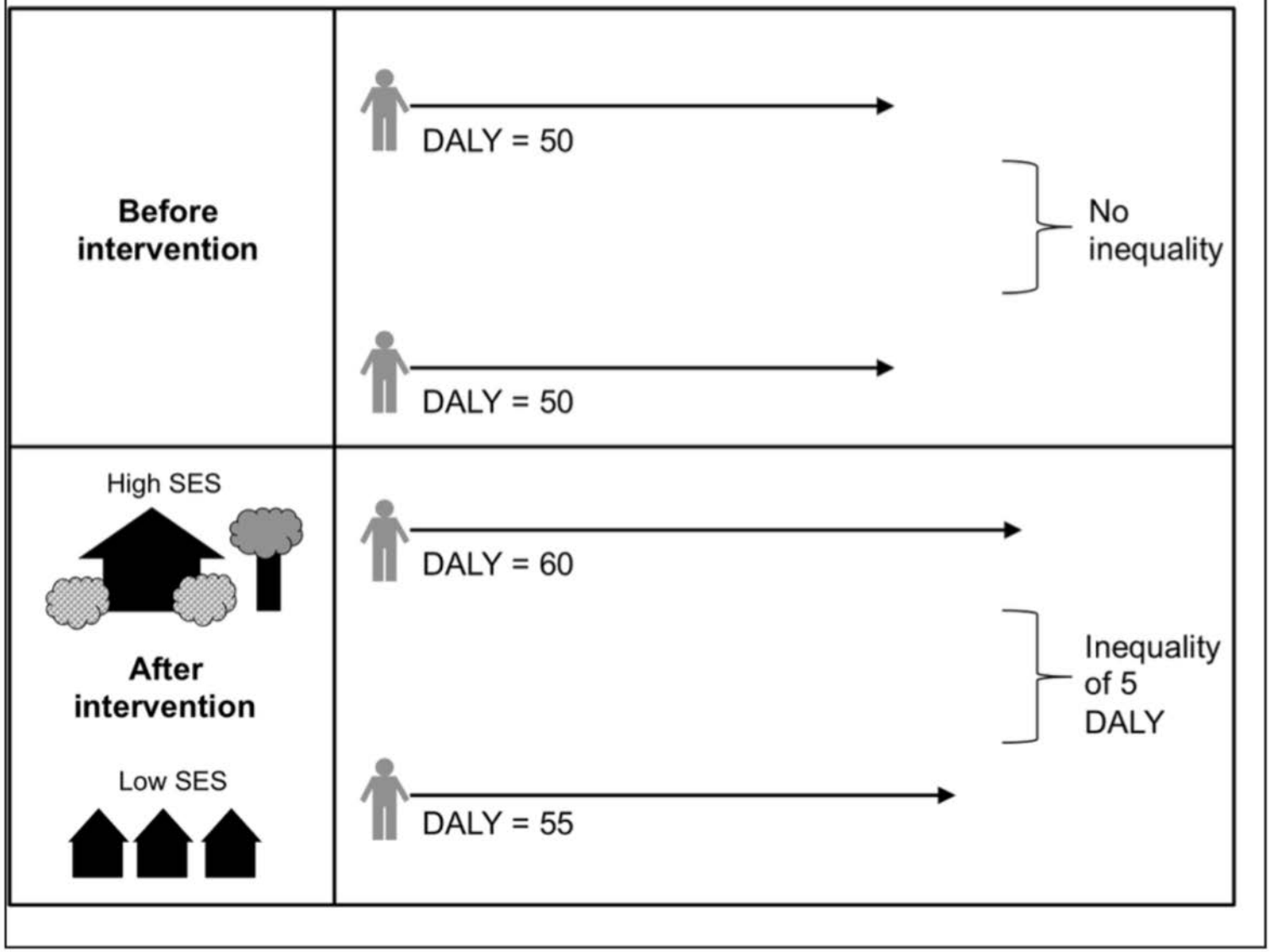
Principle 8. Efforts to improve overall population health may disadvantage some groups; whether equity or efficiency is preferable is a matter of values

Figure 1. Gaining overall population health while increasing health inequity



DALY = disability adjusted life years

Figure 2. Gaining overall population health while creating health inequalities



DALY = disability adjusted life years; SES = socioeconomic status

In a city of a million residents, 40 percent expansion of transit developments has annual health benefit of $216 million

https://www.cdc.gov/policy/hst/hi5/publictransportation/index.html

Health Benefits. 2010, Victoria Transport Policy Institute http://www.apta.com/resources/reports

Towards improving the health of urban populations

Mount Pleasant, South Carolina

UrbanAdvantage

Existing conditions: high speed center road with local serving side roads

Mount Pleasant, South Carolina

UrbanAdvantage

New sidewalks, one-way local access lane, parking lane, street lamps

Mount Pleasant, South Carolina

UrbanAdvantage

New infill development at sidewalks

Mount Pleasant, South Carolina

UrbanAdvantage

Palmetto trees in median

Mount Pleasant, South Carolina

UrbanAdvantage

Street trees on far side

Mount Pleasant, South Carolina

UrbanAdvantage

Street trees on near medians

Mount Pleasant, South Carolina

UrbanAdvantage

Street trees on near side

Mount Pleasant, South Carolina

UrbanAdvantage

Increased street life

Mount Pleasant, South Carolina

UrbanAdvantage

Light rail in median

Mount Pleasant, South Carolina

UrbanAdvantage

Residential development alternative

“A healthy city is one that continually creates and improves its physical and social environments and expands the community resources that enable people to mutually support each other in performing all the functions of life and developing to their maximum potential.”

http://www.euro.who.int/en/health-topics/environment-and-health/urban-health/activities/healthy-cities/who-european-healthy-cities-network/what-is-a-healthy-city

EXECUTIVE SUMMARY

The Urban Health Penalty

New Dimensions and Directions in Inner-City Health Care

Introduction

For many years, inner cities have presented major challenges to communities, health care providers and their governments. Violence, poverty and other social ills are often perceived as fates suffered by residents of inner-city neighborhoods, and many agree that populations in those settings face the greatest challenges to health and survival in the United States. Yet few studies have been done to

Vlahov D, Galea S, Freudenberg N. Toward an urban health advantage. Journal of Public Health Management Practice 2005;11(3):256-258. PMID: 15829840.

AMERICAN COLLEGE OF PHYSICIANS
INTERNAL MEDICINE

Urban Health

Toward an Urban Health Advantage

David Vlahov, Sandro Galea, and Nick Freudenberg

For many years, inner cities have presented major challenges to communities, health care providers and their governments. Violence, poverty and other social ills are often perceived as fates suffered by residents of inner-city neighborhoods, and many agree that populations in those settings face the greatest challenges to health and survival in the United States. Yet few studies have been done to

Vlahov D, Galea S, Freudenberg N. Toward an urban health advantage. Journal of Public Health Management Practice 2005;11(3):256-258. PMID: 15829840.

twitter/@sandrogalea

sgalea@bu.edu