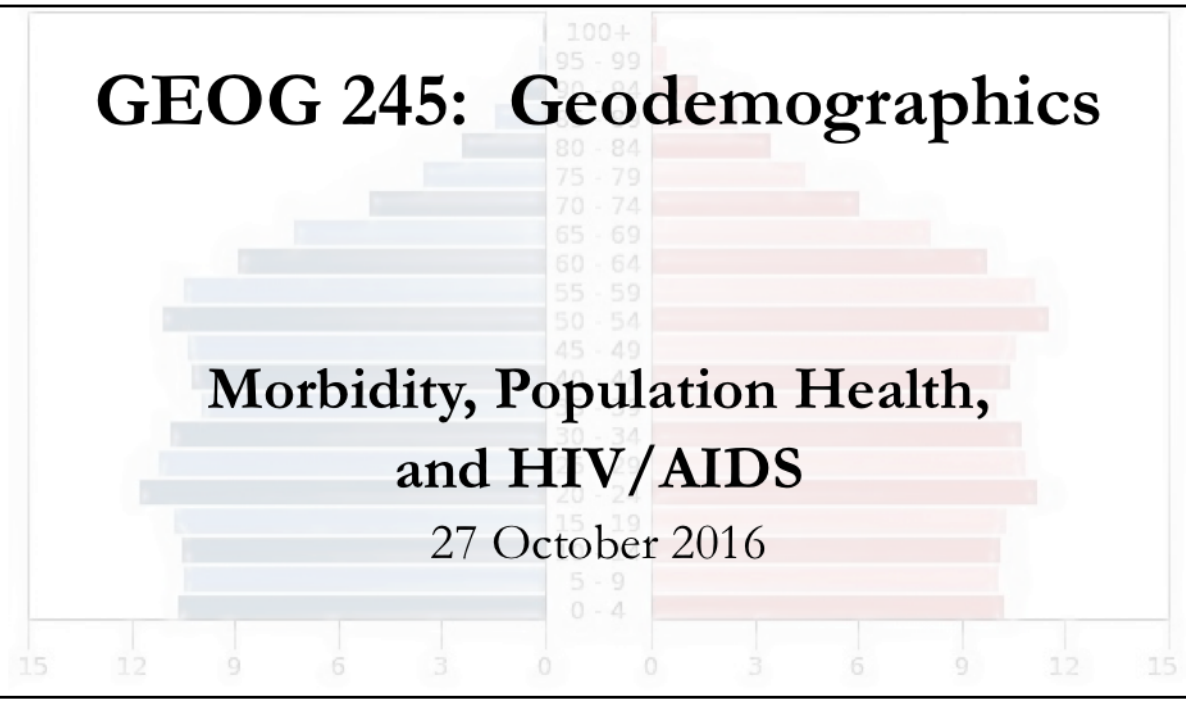
GEOG 245: Geodemographics

Morbidity, Population Health, and HIV/AIDS

27 October 2016



Announcements

- Reminder: Midterm is next Tuesday.
- Extra Office Hours: Tomorrow (Friday, Oct. 28) from 10am-noon in Smith 411.
  - Questions about the midterm
  - Help with ArcGIS

I have updated the midterm review sheet on canvas, so it is now complete.

I will be holding extra office hours tomorrow to help folks with GIS and to answer any questions as you start studying for the midterm.

Plan for Today

- Practice Quiz
- Morbidity
- Population Health
- The Geodemographics of HIV/AIDS

Practice Quiz

- I will collect these for participation points only (I will not record your grade)
- This is to help you get a sense of what kinds of questions you might see on the midterm
- Take 10 minutes to do the quiz and then we will discuss the answers

Plan for Today

- Practice Quiz
- Morbidity
- Population Health
- The Geodemographics of HIV/AIDS

What is Morbidity?

What is Morbidity?

- The quality or state of being ill/having a disease
- The relative incidence or prevalence of disease in a population

Think of morbidity as the opposite of health.

So what then is incidence?

Incidence

- The number of new cases of a disease within a given time period

And what is prevalence?

Prevalence

- The number of all cases (new and old) of a disease at a specific point in time
- Prevalence = incidence * duration

We can calculate prevalence if we know the incidence and how long the disease typically lasts. For example, if we know that there were 5 new colds diagnosed today and that the average cold lasts a week, we could estimate that the prevalence of this particular cold would be 35 (5 * 7).

What is Morbidity?

- The quality or state of being ill/having a disease
- The relative incidence or prevalence of disease

So, morbidity then is essentially the number of cases of a disease. Both incidence and prevalence are measures of morbidity.

How is this different than mortality?

Why do demographers look at morbidity and mortality separately?

How is this different than mortality?

- While disease can hasten death, it does not always

Why do demographers look at morbidity and mortality separately?

Why measure disease at all?

- Helps us understand and identify epidemics
- To see change in incidence/prevalence over time

And what is an epidemic?

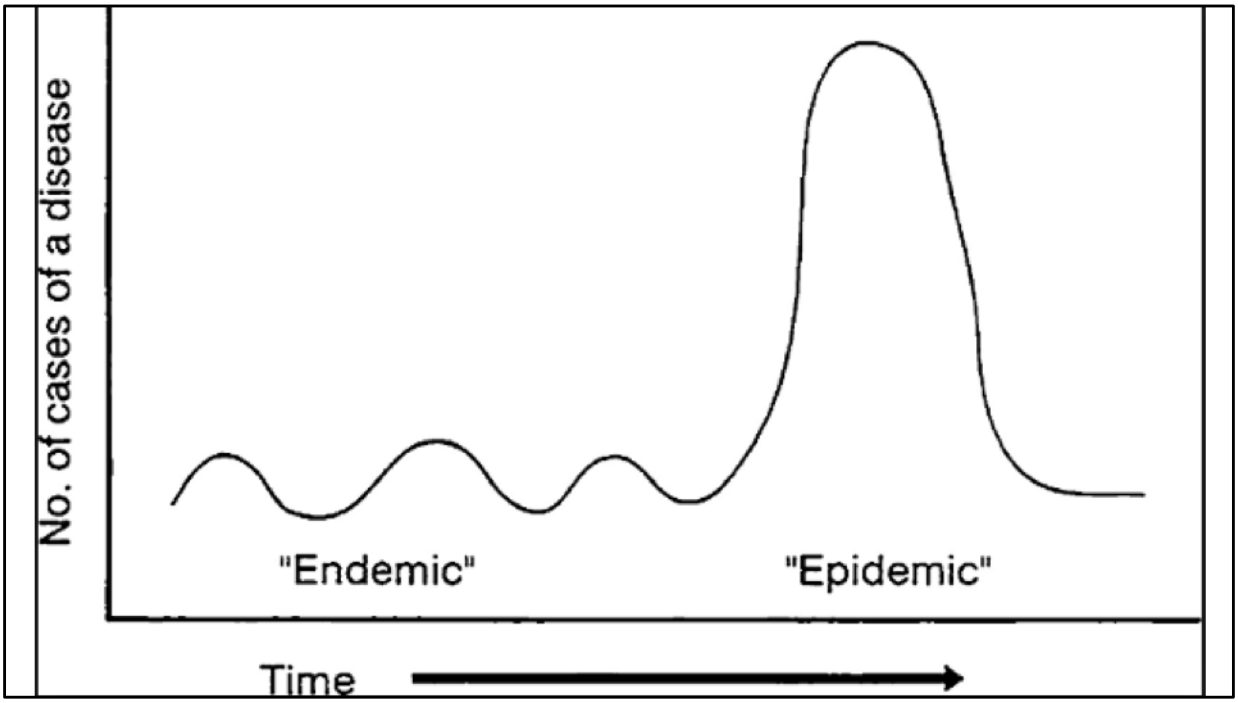
Epidemic

- An atypical rise in the incidence of a disease
- In other words, a sudden outbreak in the number of cases of a disease above normal levels

And this is contrasted with endemic diseases…

Endemic

- Refers to a disease that remains in the population at low levels


No. of cases of a disease
"Endemic"
"Epidemic"
Time

What is a Pandemic?

This is another common term we seen thrown around.

Pandemic

- Epidemic that achieves global distribution

Generally, even if an epidemic is only happening on a few continents, we still call it a pandemic, though officially, pandemic means that it is everywhere in the world.

Questions?

So how do we measure morbidity?

We said that we can use incidence and prevalence as types of measures, but more specifically, how do we go about measuring a disease?

So how do we measure morbidity?

- Mortality rates

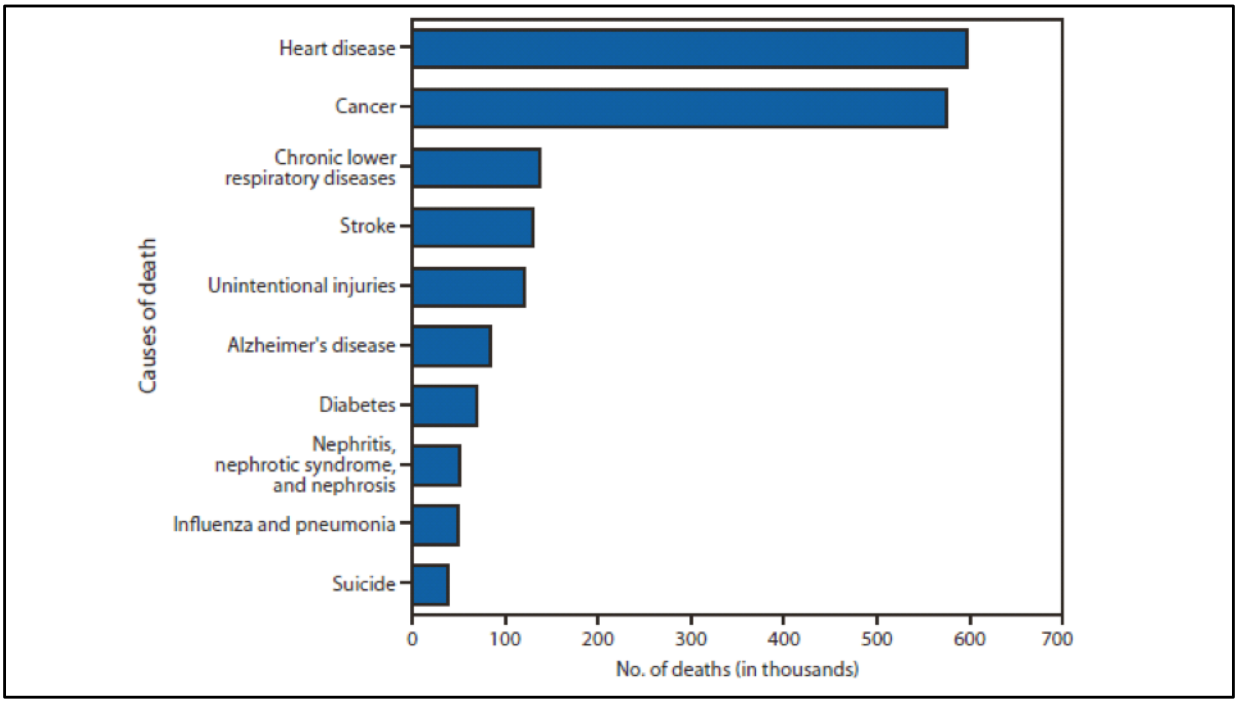
So we already discussed mortality rates a couple weeks ago, but they are often used to measure morbidity as well. Remember cause specific death rates and case fatality rates

Cause Specific Death Rate

$$\text{CSDR} = \frac{\text{Number of Deaths from a Specific Cause}}{\text{Total Population}} * K$$

- This tells us how many people a specific disease kills

Note, K is usually 100,000 not 1,000


Heart disease
Cancer
Chronic lower respiratory diseases
Stroke
Unintentional injuries
Alzheimer's disease
Diabetes
Nephritis, nephrotic syndrome, and nephrosis
Influenza and pneumonia
Suicide
Causes of death
0
100
200
300
400
500
600
700
No. of deaths (in thousands)

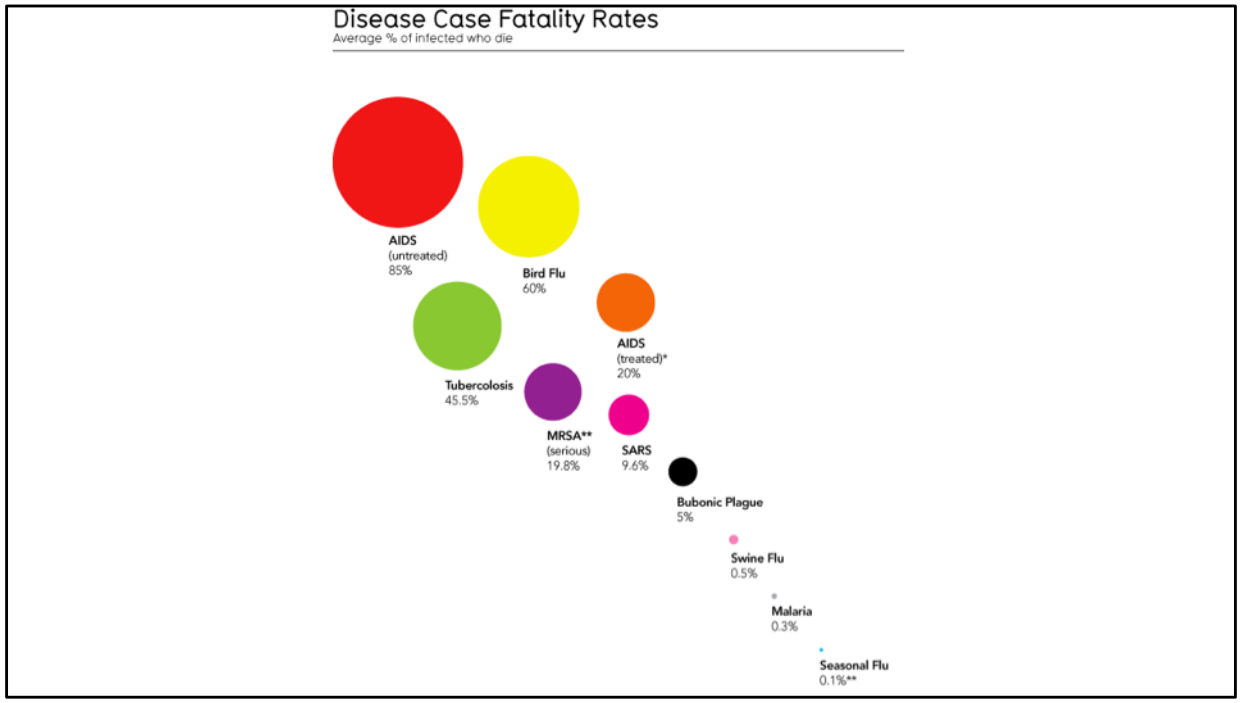
Case Fatality Rate

$$\text{CFR} = \frac{\text{Number of Deaths from Specific Cause}}{\text{Number of Cases of that Cause}} * K$$

- This tells us how deadly a disease is to those who get it

Generally K is just a round number to make the number intelligible.

Ex: If 1000 people are diagnosed with a particular disease, but only three die from it, the CFR would be .3 / 100 cases.


Disease Case Fatality Rates
Average % of infected who die
AIDS
(untreated)
85%
Bird Flu
60%
AIDS
(treated)*
20%
Tubercolosis
45.5%
MRSA**
(serious)
19.8%
SARS
9.6%
Bubonic Plague
5%
Swine Flu
0.5%
Malaria
0.3%
Seasonal Flu
0.1%**

So how do we measure morbidity?

- Mortality rates
- Infection rates

Incidence

- The number of new cases of a disease within a given time period

- This tells us how many people are being infected

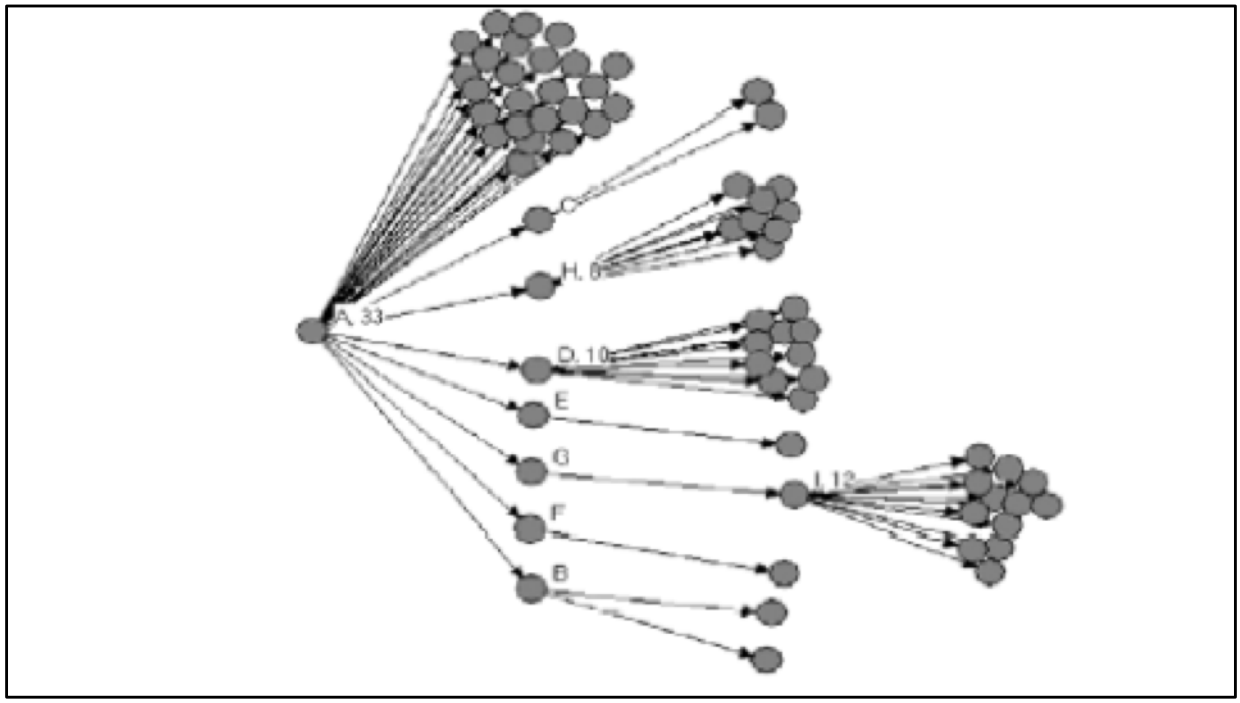
R_0

- Pronounced 'R nought' (R not)
- The number of new people the average infected person will infect
- Reproductive rate of the disease

- This is a measure of how quickly people are being infected

R_0 is based on the contact rate (how many people that infected person is going to encounter), the probability of transition during any given encounter, and the duration of that contact.

The easiest way to think about this is to break it down:
If R_0 is higher than 1, what do you think is going to happen? (The disease will spread)
If R_0 is equal to 1, what do you think is going to happen? (The disease will remain constant (be endemic))
If R_0 is less than 1, what do you think is going to happen? (The disease will die off)



This is a picture of that R_0 being drawn based on the SARS outbreak in China. They identified the source of the outbreak (person A) and that that person was a superspreader (as were person H, D, and I), but others only infected one or two people. So, for this outbreak, R_0 isn't really all that meaningful as there is huge variation in how many people someone infects.

Various R_0 across diseases

Measles: 12-18
Pertussis: 12-17
Diphtheria: 6-7
Smallpox: 5-7
Polio: 5-7
Rubella: 5-7
Mumps: 4-7
HIV/AIDS: 2-5
SARS: 2-5
1918 Influenza: 2-3
Seasonal Influenza: ~1

Challenges to knowing incidence

- Morbidity is not always observed

- Instead, often consider incidence of diagnosis
- Or we use other measures to approximate incidence

Think about the person who gets a cold, but doesn't go to the doctor. They then don't get counted.

Approximating Incidence

- Google Flu Trends

A few years back, google announced that it could predict a flu outbreak two weeks ahead of the CDC based on people's search terms. The idea was that people search for flu related terms when they were sick with the flu. But, after a couple years the flu tracker failed (with the addition of Google's suggested search feature and add-ons) and while google continues to send flu related search data to the CDC, they haven't published a new flu tracker for the public.

How else might you approximate incidence?

So how do we measure morbidity?

- Mortality rates
- Infection rates
- Total number of cases

Prevalence

- The number of all cases (new and old) of a disease at a specific point in time
- Prevalence = incidence * duration
- Prevalence = Total number of cases / total population

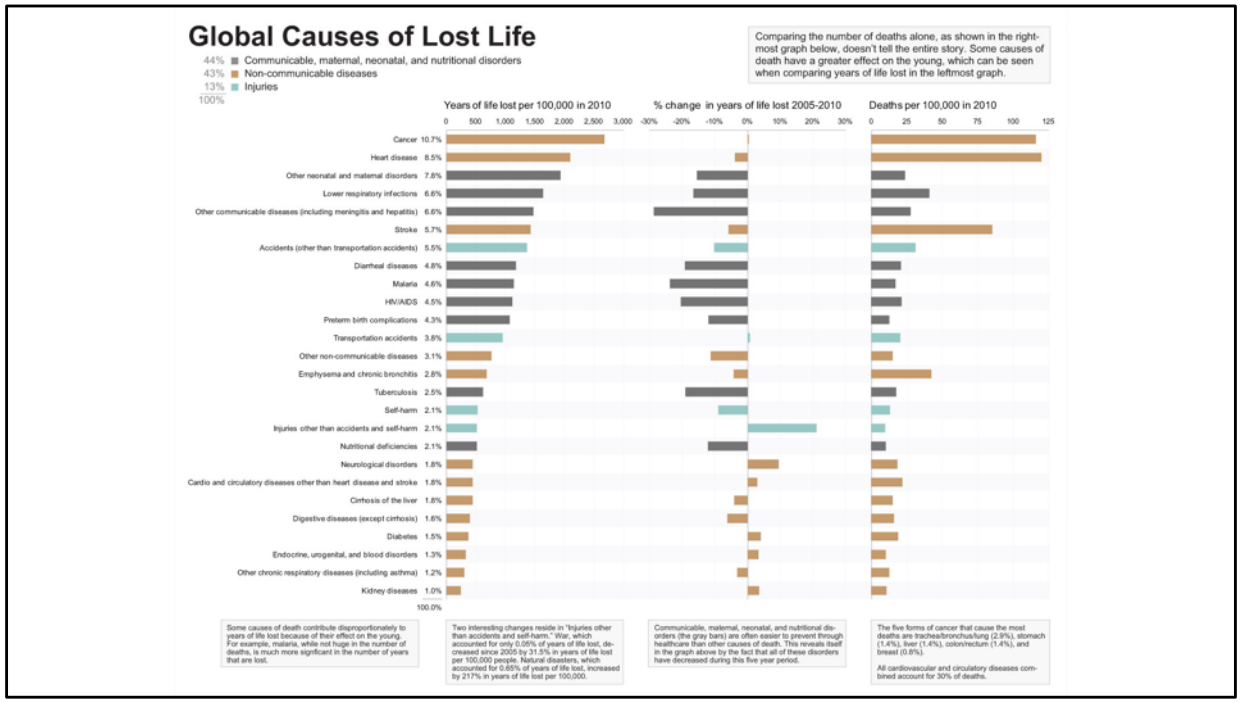
So how do we measure morbidity?

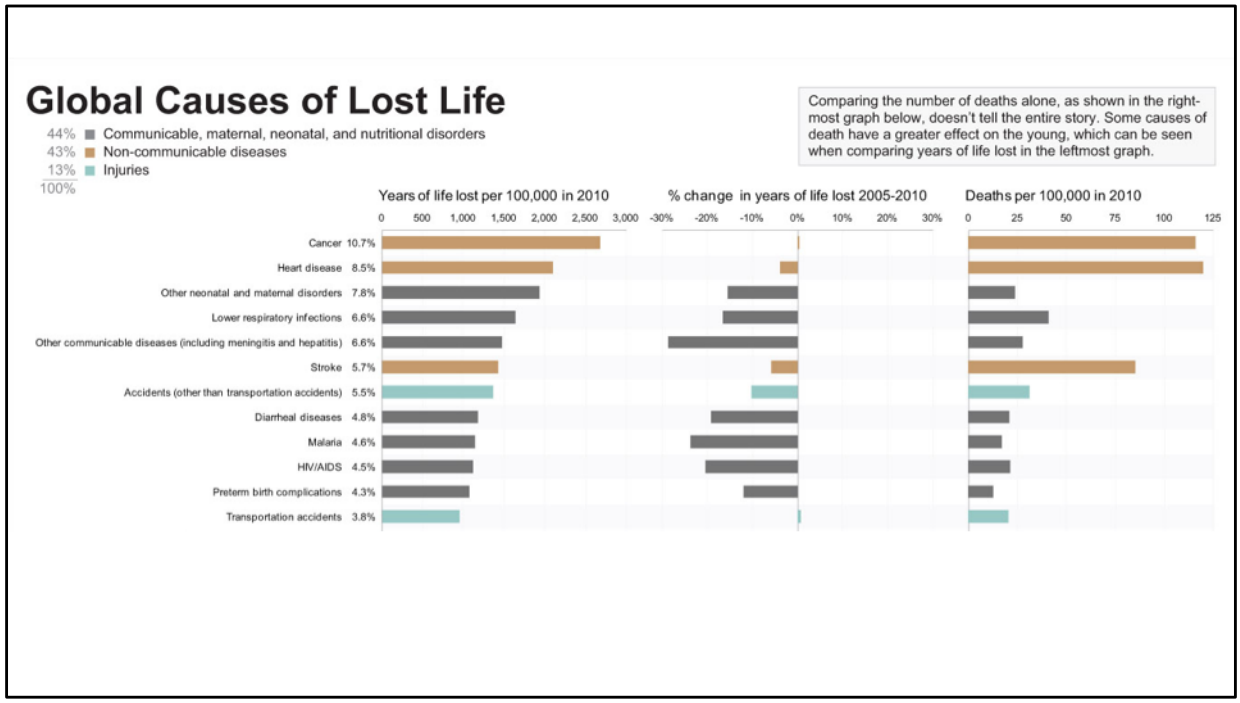
- Mortality rates
- Infection rates
- Total number of cases
- Effect on society

Years of Life Lost (YLL)

- An estimate of the difference between the age at which people die of a particular cause and the average life expectancy
- YLL sums the total number of years lost from a particular cause

Which diseases is this going to give the heaviest weight to? (those that effect early in life—childhood diseases and accidents)


Global Causes of Lost Life
44% Communicable, maternal, neonatal, and nutritional disorders
43% Non-communicable diseases
13% Injuries
100%
Comparing the number of deaths alone, as shown in the right-most graph below, doesn't tell the entire story. Some causes of death have a greater effect on the young, which can be seen when comparing years of life lost in the leftmost graph.
Years of life lost per 100,000 in 2010
% change in years of life lost 2005-2010
Deaths per 100,000 in 2010
Cancer 10.7%
Heart disease 8.5%
Other neonatal and maternal disorders 7.8%
Lower respiratory infections 6.6%
Other communicable diseases (including meningitis and hepatitis) 6.6%
Stroke 5.7%
Accidents (other than transportation accidents) 5.5%
Diarrheal diseases 4.8%
Malaria 4.6%
HIV/AIDS 4.5%
Preterm birth complications 4.3%
Transportation accidents 3.8%
Other non-communicable diseases 3.1%
Emphysema and chronic bronchitis 2.8%
Tuberculosis 2.5%
Self-harm 2.1%
Injuries other than accidents and self-harm 2.1%
Nutritional deficiencies 2.1%
Neurological disorders 1.8%
Cardio and circulatory diseases other than heart disease and stroke 1.8%
Cirrhosis of the liver 1.8%
Digestive diseases (except cirrhosis) 1.6%
Diabetes 1.5%
Endocrine, urogenital, and blood disorders 1.3%
Other chronic respiratory diseases (including asthma) 1.2%
Kidney diseases 1.0%
100.0%
Some causes of death contribute disproportionately to years of life lost because of their effect on the young. For example, malaria, while not huge in the number of deaths, is much more significant in the number of years that are lost.
Two interesting changes reside in "Injuries other than accidents and self-harm." War, which accounted for only 0.05% of years of life lost, decreased since 2005 by 31.5% in years of life lost per 100,000 people. Natural disasters, which accounted for 0.65% of years of life lost, increased by 217% in years of life lost per 100,000.
Communicable, maternal, neonatal, and nutritional disorders (the gray bars) are often easier to prevent through healthcare than other causes of death. This reveals itself in the graph above by the fact that all of these disorders have decreased during this five year period.
The five forms of cancer that cause the most deaths are trachea/bronchus/lung (2.9%), stomach (1.4%), liver (1.4%), colon/rectum (1.4%), and breast (0.8%).
All cardiovascular and circulatory diseases combined account for 30% of deaths.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Years of life lost per 100,000 in 2010
0 500 1,000 1,500 2,000 2,500 3,000
% change in years of life lost 2005-2010
-30% -20% -10% 0% 10% 20% 30%
Deaths per 100,000 in 2010
0 25 50 75 100 125
Cancer 10.7%
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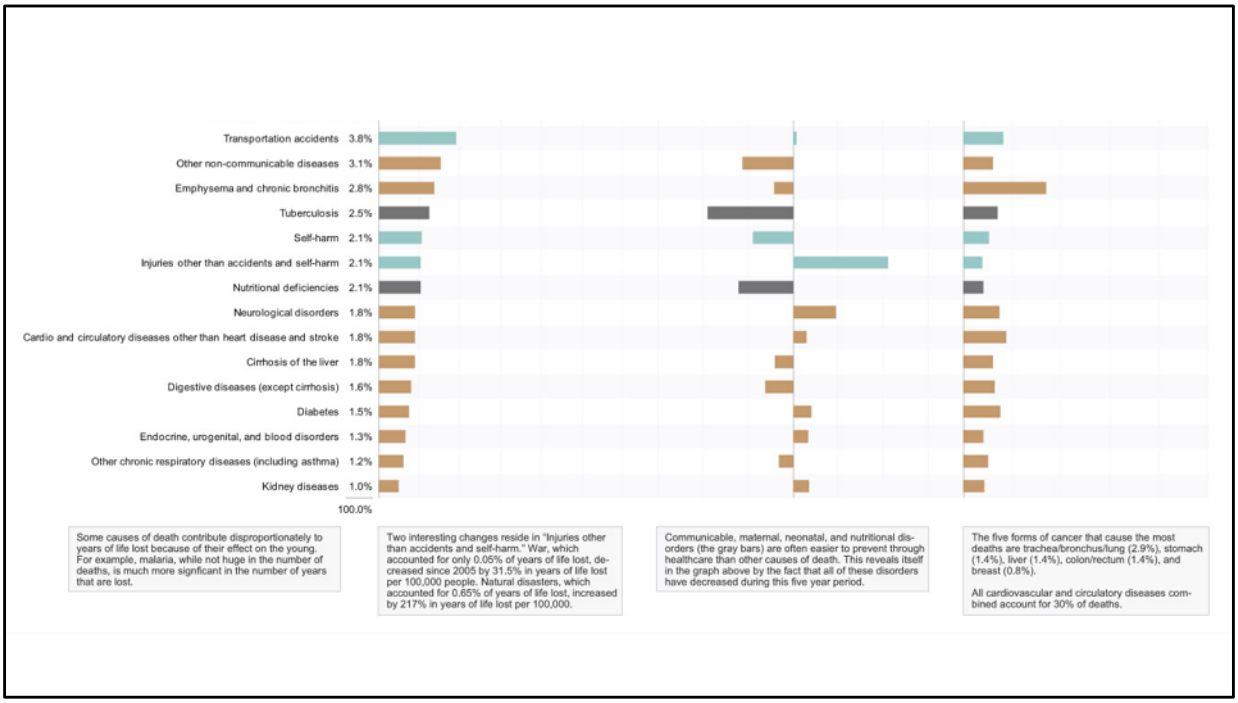
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Years of Health Lost (YHL)

- An estimate of the amount of time someone lives with disease
- YHL sums the total number of years of morbid (unhealthy) life lived because of a particular cause

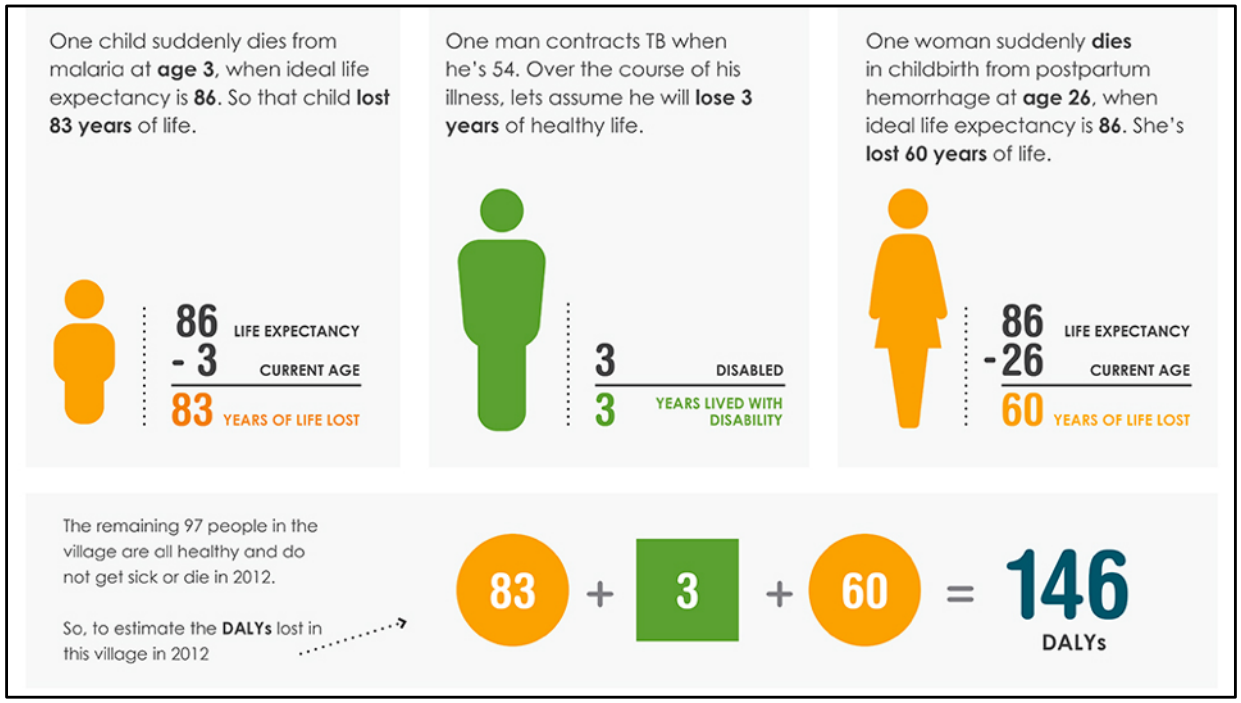
Strictly speaking, YLL is a measure of mortality, not morbidity, so if we want to focus specifically on morbidity, we generally look at YHL.

Which diseases are going to be disproportionately visible in YHL statistics? (chronic, long-lasting diseases)

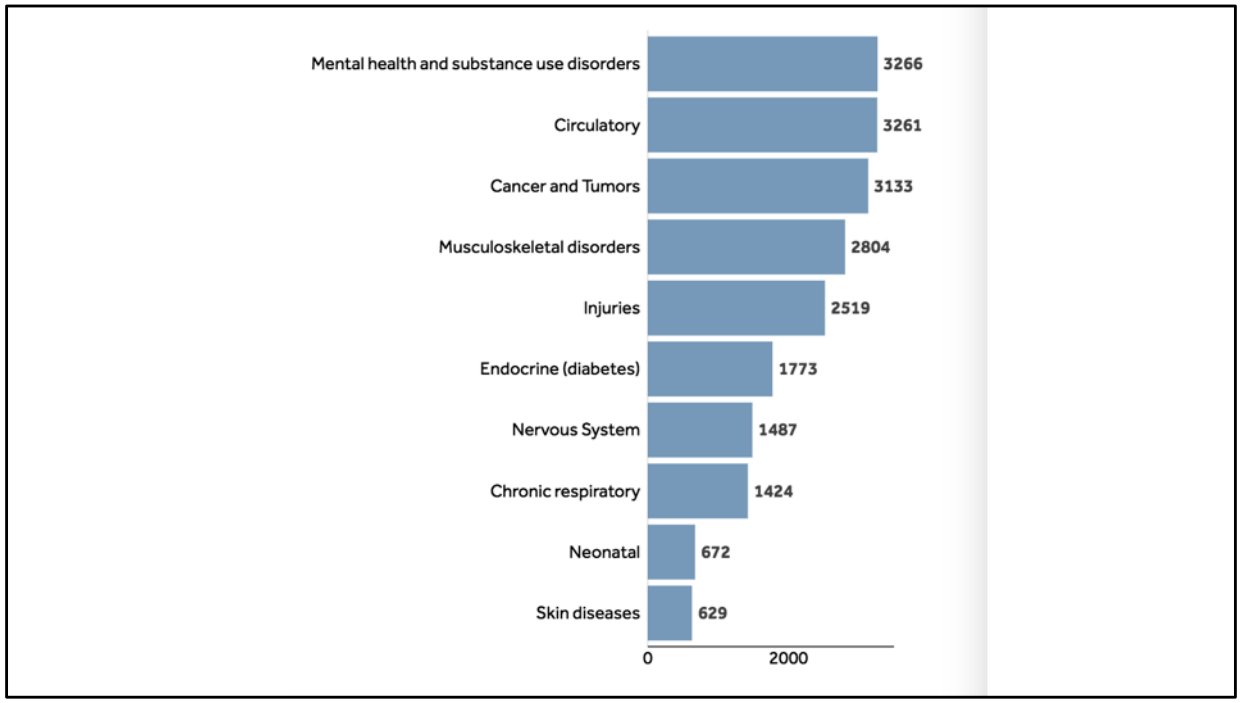
Disability Adjusted Life Years (DALYs)

- YLL + YHL
- The total number of years of healthy life lost to a particular disease/cause

Most often, rather than looking at YLL and YHL separately, we look at them together.

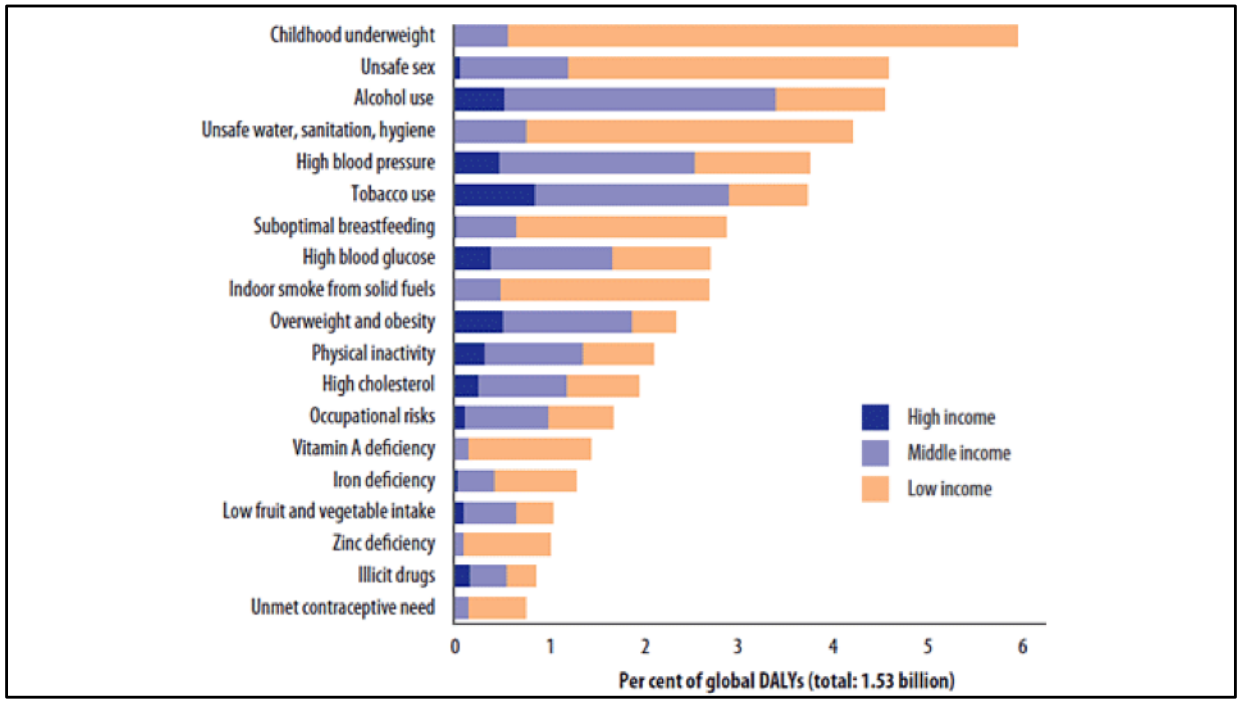


To give an example…

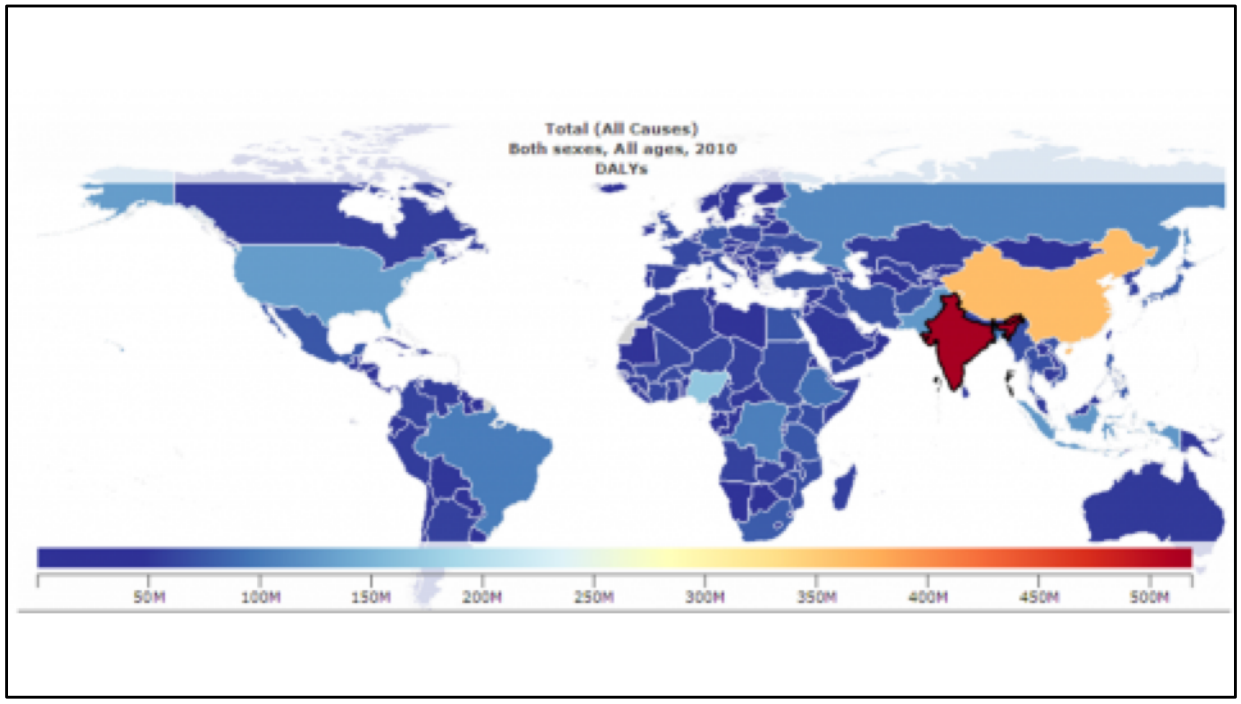


DALYs in the US (standardized by rate per 100,000 population). Data from the Institute of Health Metrics and Evaluation 2013.

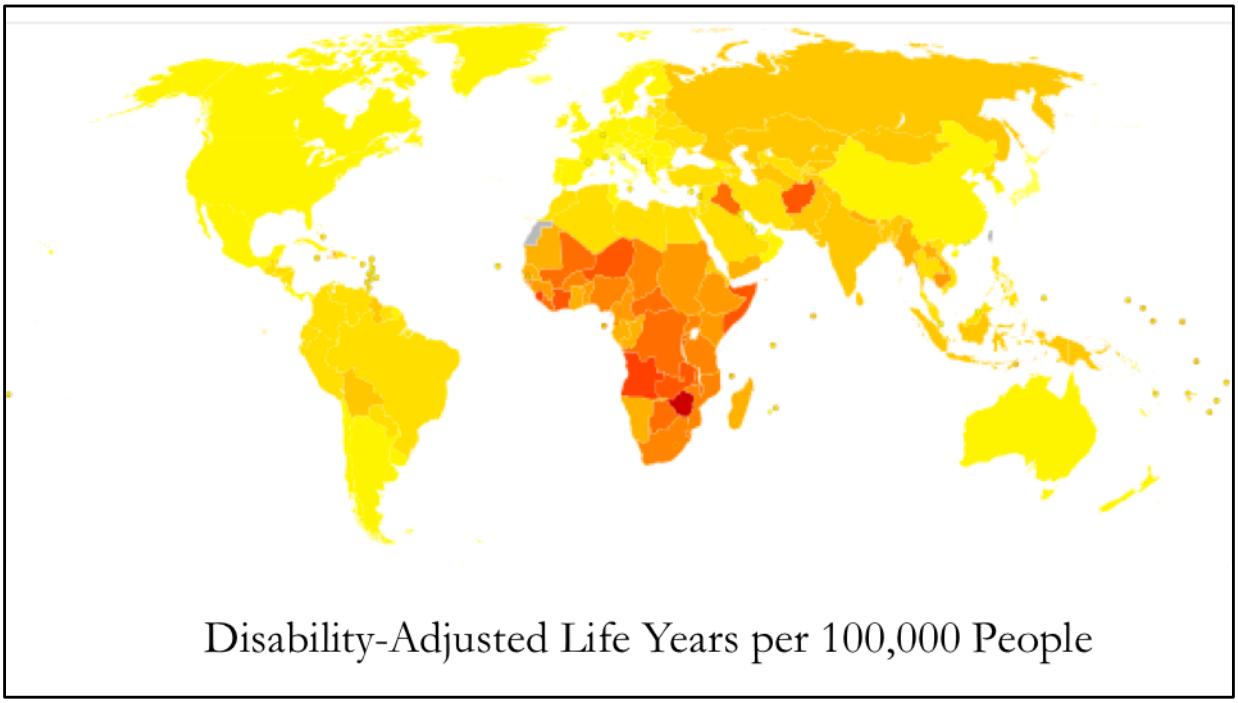
What would we expect to see differently if we were looking at the global population?



What can we tell from this graph?



Why do you think China and India show up so significantly on this map? (large populations)



DALYs from all causes in 2004

When we normalize the map (What does normalize mean? Just that we divide the the causes by population or some other standardizing unit in order to better be able to compare groups of different sizes), we see that China and India aren't the worst off, but instead Sub-Saharan Africa, Iraq, and Afghanistan are. What is producing this pattern? War and HIV/AIDS.

But why do demographers look at morbidity?

So now that we have discussed how demographers look at morbidity, why are they doing it?

But why do demographers look at morbidity?

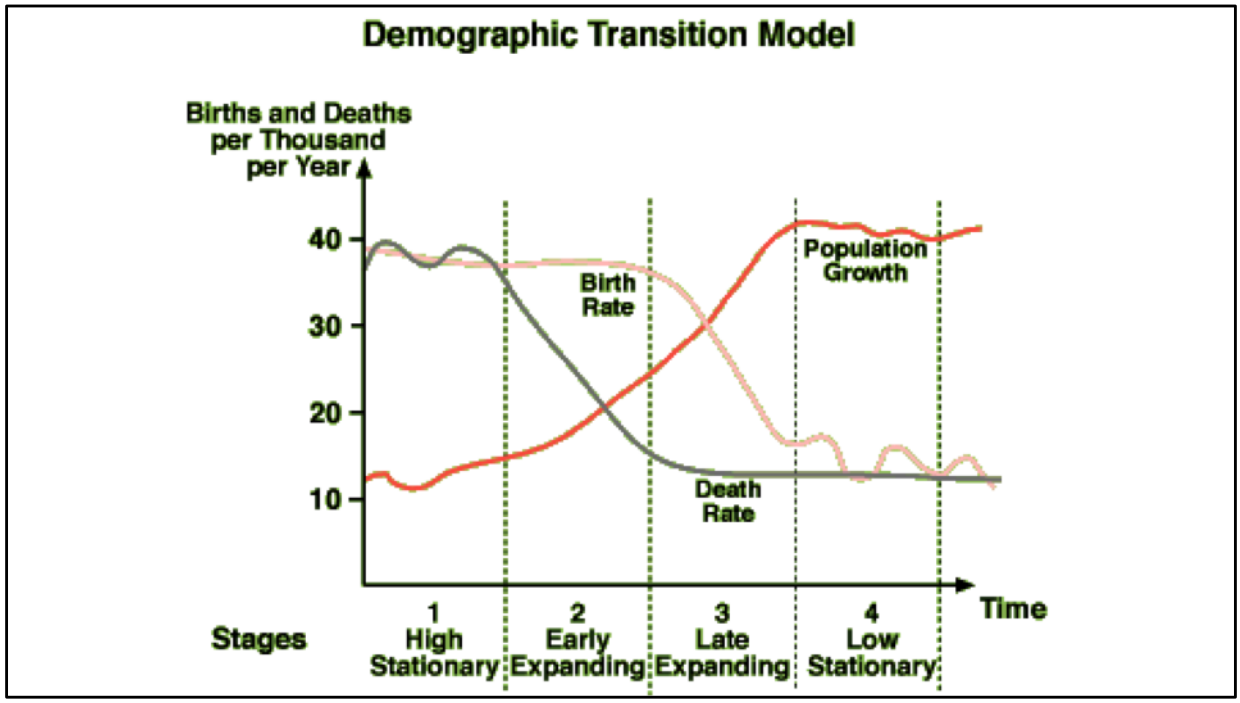
- Disease is a societal problem

Almost all societies view disease as a negative and spend a great deal of time and money getting rid of it. And disease is generally not found in isolation. In other words, rarely is a single person infected with something randomly and it doesn't spread to anyone else. With communicable diseases, disease is a population problem because the entire population becomes at risk as the disease spreads. With non-communicable diseases, growing research shows high variation in the rates among different populations suggesting social and environmental risk factors that exist at a population level.

But why do demographers look at morbidity?

- Disease is a societal problem
- There is a close relationship between morbidity and population processes

Obviously disease can effect mortality rates (one of the three most important demographic concerns (along with fertility and migration)), but it can also effect fertility through the likelihood of success in childbearing, marriage, divorce, and widowhood rates, and even migration itself. For example, a number of countries have migration restrictions on anyone infected with HIV/AIDS. In the UAE, in order to get more than a tourist visa, you need to be tested for HIV and a positive test is grounds for a visa denial and deportation (if you are already in the country).



Remember the demographic transition we talked about week 1? This is also sometimes referred to as the epidemiologic transition as it is spurred by a declining death rate due to medical advances. This declining death rate reflects a change in the morbidity of the population with the primary causes of morbidity shifting from the highly mortal infectious diseases to the more debilitating (but only really mortal after childbearing years) chronic diseases due to expanded public health and sanitation.

Where do we get morbidity data?

- Death records (death certificates)
- Historic records (skeletal remains, diaries, physician records, newspapers, etc.)
- Health surveys
- Disease surveillance systems (reportable diseases)

Reportable diseases: In the US, the CDC requires physicians to report to local, state or national public health agencies any cases of a wide variety of diseases that are deemed of high public health importance. This happens in other countries as well and the data is shared up with the WHO.

What diseases must be reported to the CDC?

Anthrax	Leprosy	Rabies
Botulism	Lyme disease	Rubella
Chicken pox	Malaria	Salmonella
Chlamydia	Measles	SARS
Cholera	Meningitis	Smallpox
Diptheria	Mumps	Syphilis
Gonorrhea	Pertussis	Tetanus
Hepatitis (A, B, & C)	Plague	Tuberculosis
Influenza (new strains)	Polio	Typhoid

This is far from all of the diseases that must be reported, but this gives you a sense of the scale of such reporting (to see a longer list go to https://medlineplus.gov/ency/article/001929.htm). While most of these are reported as just number of infections, some require your medical information and name to be shared as well. For example, with tuberculosis, if you refuse treatment or your doctor thinks you are not reliably taking your medication, they can report you to the CDC and the government legally has the right to incarcerate you in order to force you to take your medication. This is an extreme case given the rise of drug resistant TB and the threat it posses to the population, but it does happen. A less extreme example: If your doctor reports that you have salmonella, the CDC or department of health will sometimes come interview you about your onset of symptoms and what you ate in the 72 hours before symptoms started in order to identify the source of contamination.

Questions?

Plan for Today

- Practice Quiz
- Morbidity
- Population Health
- The Geodemographics of HIV/AIDS

So what is Population Health?

So what is Population Health?

- The consideration of health outcomes of a group of individuals (including subgroups within a population)

Essentially it is the examination of health by demographers. If doctors and physicians look at individual health, demographers and people studying population health look at the health of a society.

Essentially, everything we just talked about is population health.

Who uses Population Health?

Or why study population health?

Who uses Population Health?

- Policy makers to establish national health policies
- Researchers to understand health determinants and risk factors

Questions?

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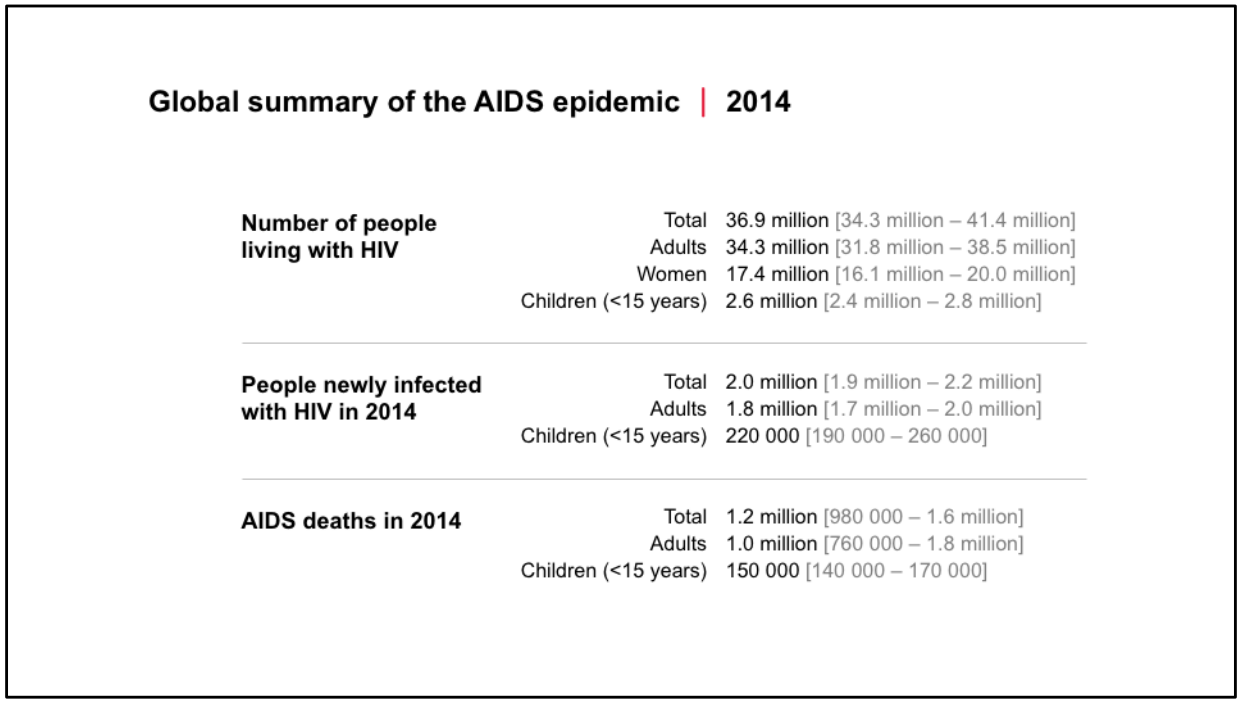


Data from UNAIDS

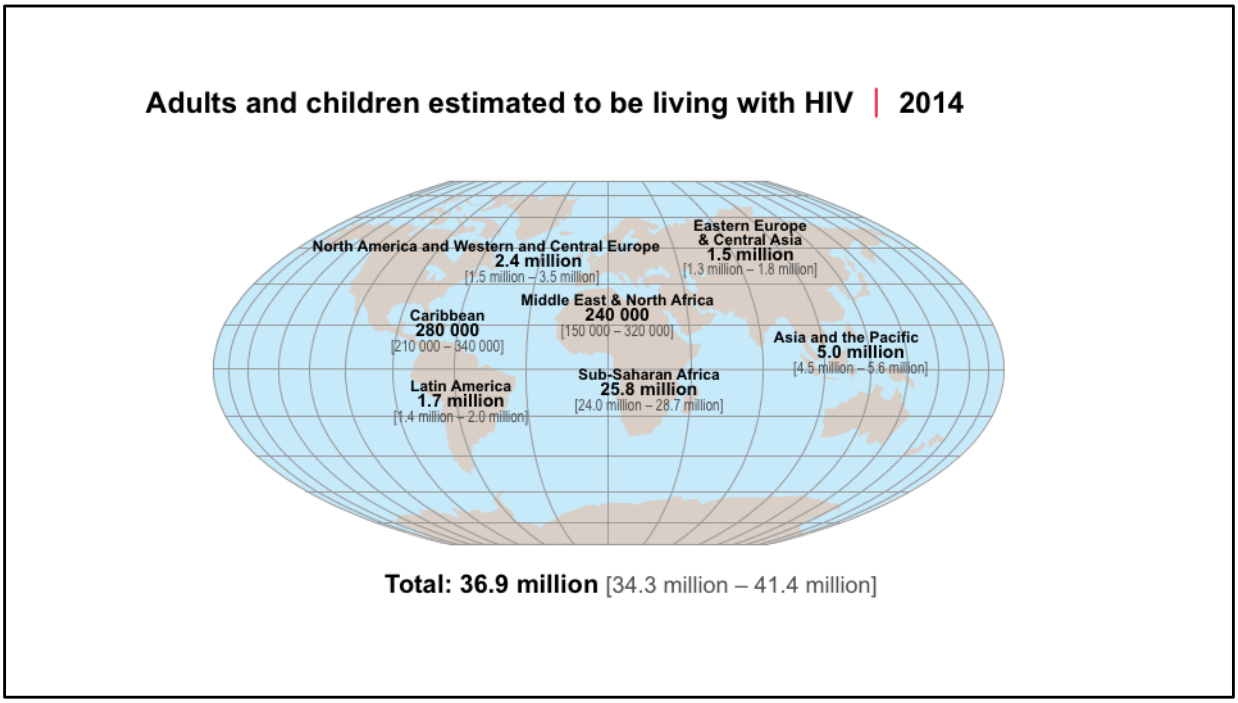
The next few slides are borrowed from UNAIDS. There is a lot of data on them, but they help paint a picture.

Regional HIV and AIDS statistics and features | 2014

	Adults and children living with HIV	Adults and children newly infected with HIV	Adult prevalence (15–49) [%]	Adult & child deaths due to AIDS
Sub-Saharan Africa	25.8 million [24.0 million – 28.7 million]	1.4 million [1.2 million – 1.5 million]	4.8% [4.5% – 5.1%]	790 000 [670 000 – 990 000]
Middle East and North Africa	240 000 [150 000 – 320 000]	22 000 [13 000 – 33 000]	0.1% [<0.1% – 0.1%]	12 000 [5300 – 24 000]
Asia and the Pacific	5.0 million [4.5 million – 5.6 million]	340 000 [240 000 – 480 000]	0.2% [0.2% – 0.2%]	240 000 [140 000 – 570 000]
Latin America	1.7 million [1.4 million – 2.0 million]	87 000 [70 000 – 100 000]	0.4% [0.4% – 0.5%]	41 000 [30 000 – 82 000]
Caribbean	280 000 [210 000 – 340 000]	13 000 [9600 – 17 000]	1.1% [0.9% – 1.3%]	8800 [5700 – 13 000]
Eastern Europe and Central Asia	1.5 million [1.3 million – 1.8 million]	140 000 [110 000 – 160 000]	0.9% [0.7% – 1.0%]	62 000 [34 000 – 140 000]
Western and Central Europe and North America	2.4 million [1.5 million – 3.5 million]	85 000 [48 000 – 130 000]	0.3% [0.2% – 0.5%]	26 000 [11 000 – 86 000]
TOTAL	36.9 million [34.3 million – 41.4 million]	2.0 million [1.9 million – 2.2 million]	0.8% [0.7% - 0.9%]	1.2 million [980 000 – 1.6 million]

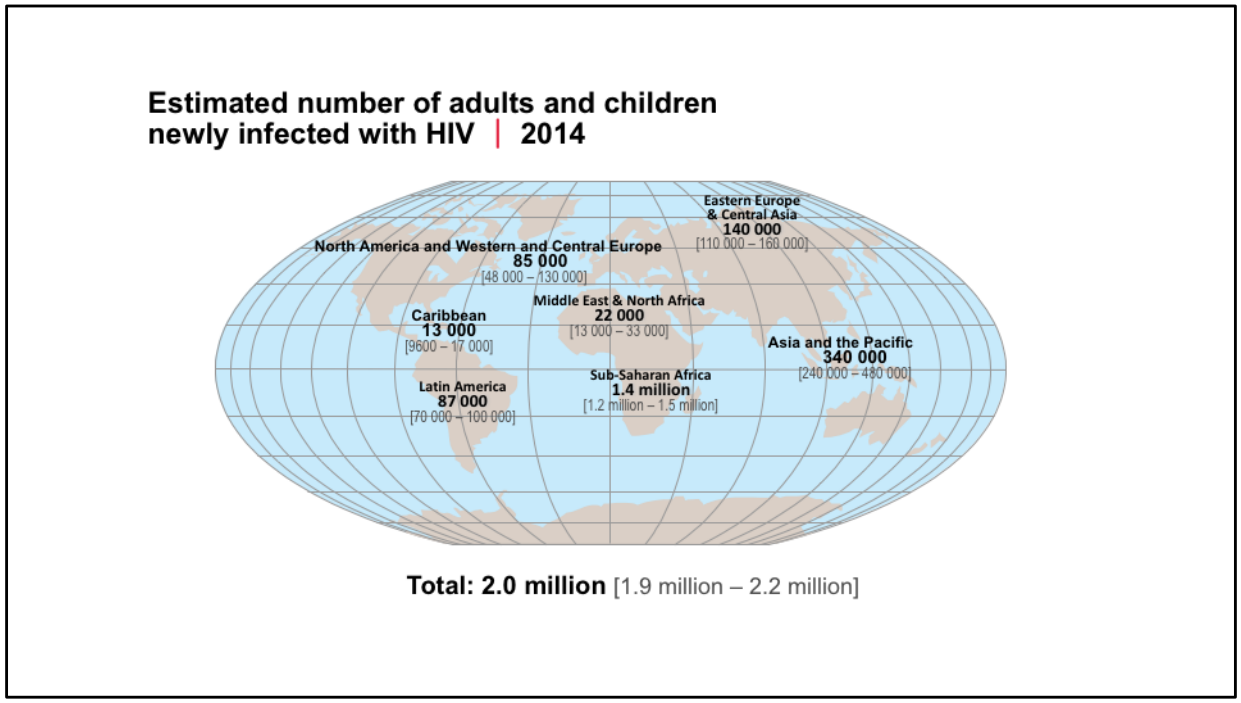
The ranges around the estimates in this table define the boundaries within which the actual numbers lie, based on the best available information.

Data from UNAIDS



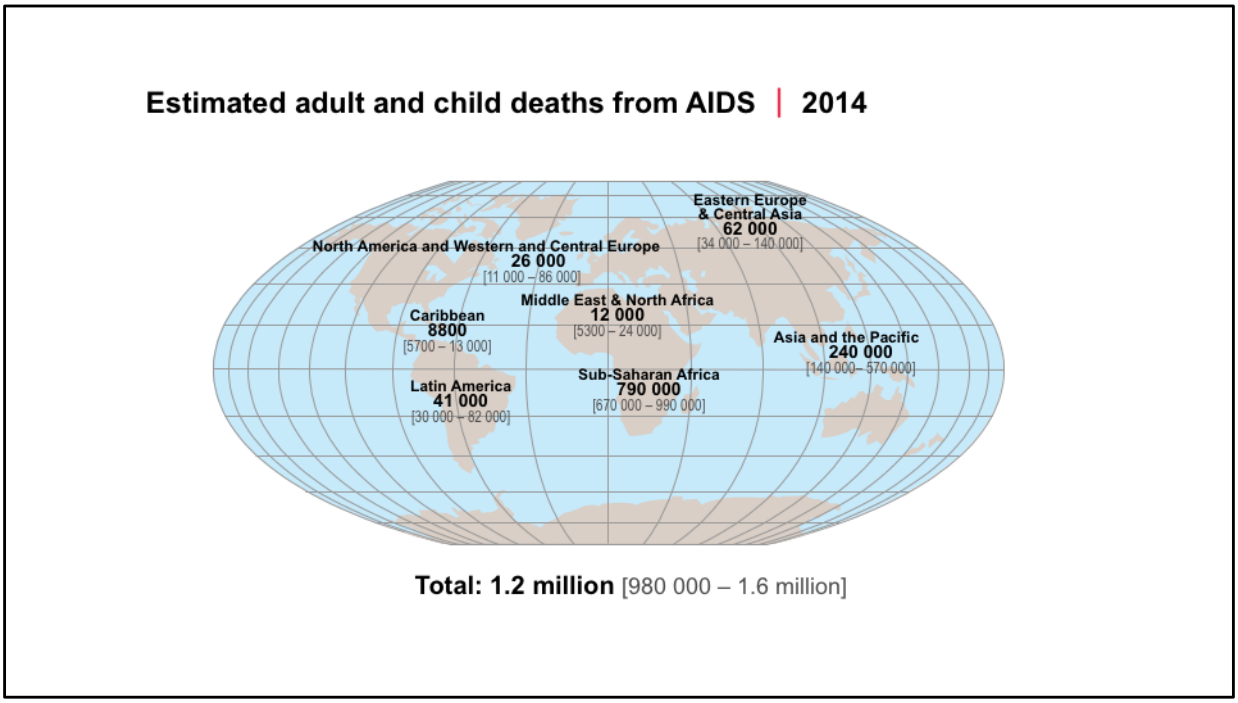
Data from UNAIDS

Prevalence



Data from UNAIDS

Incidence



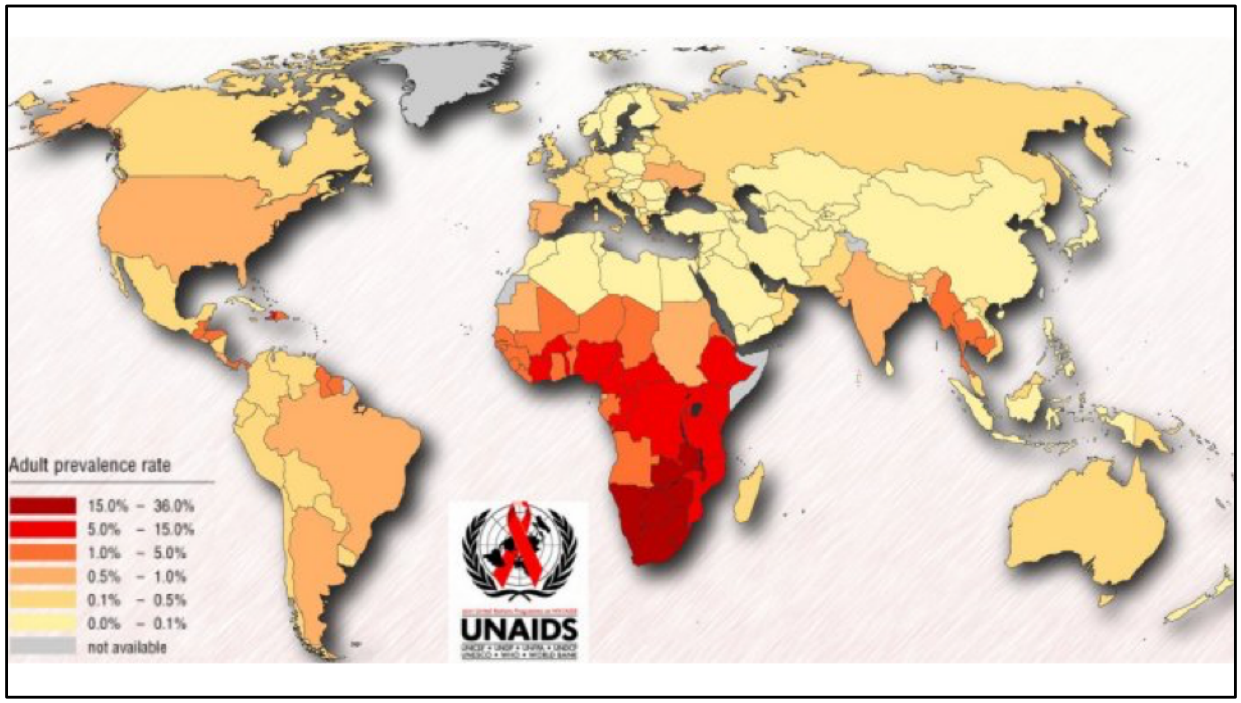
Data from UNAIDS

Mortality

About 5,600 new HIV infections a day in 2014

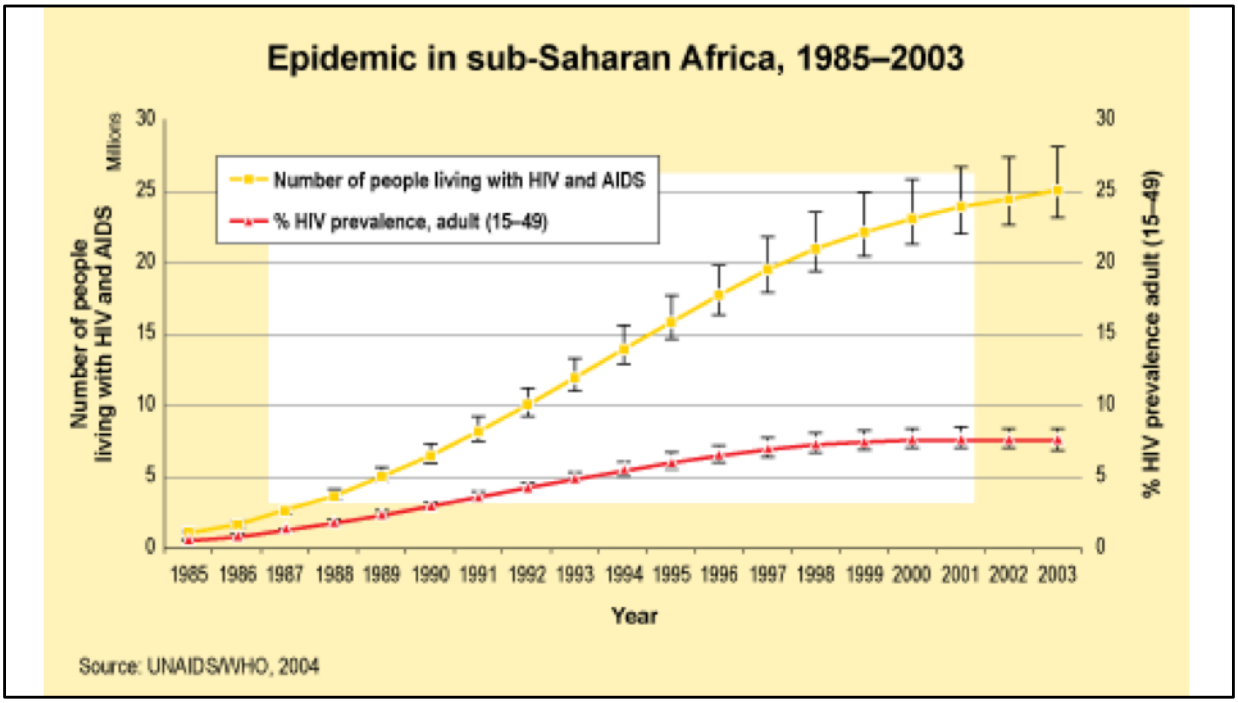
- About 66% are in Sub Saharan Africa
- About 600 are in children under 15 years of age
- About 5,000 are in adults aged 15 years and older, of whom:
  - almost 48% are among women
  - about 30% are among young people (15-24)

Data from UNAIDS

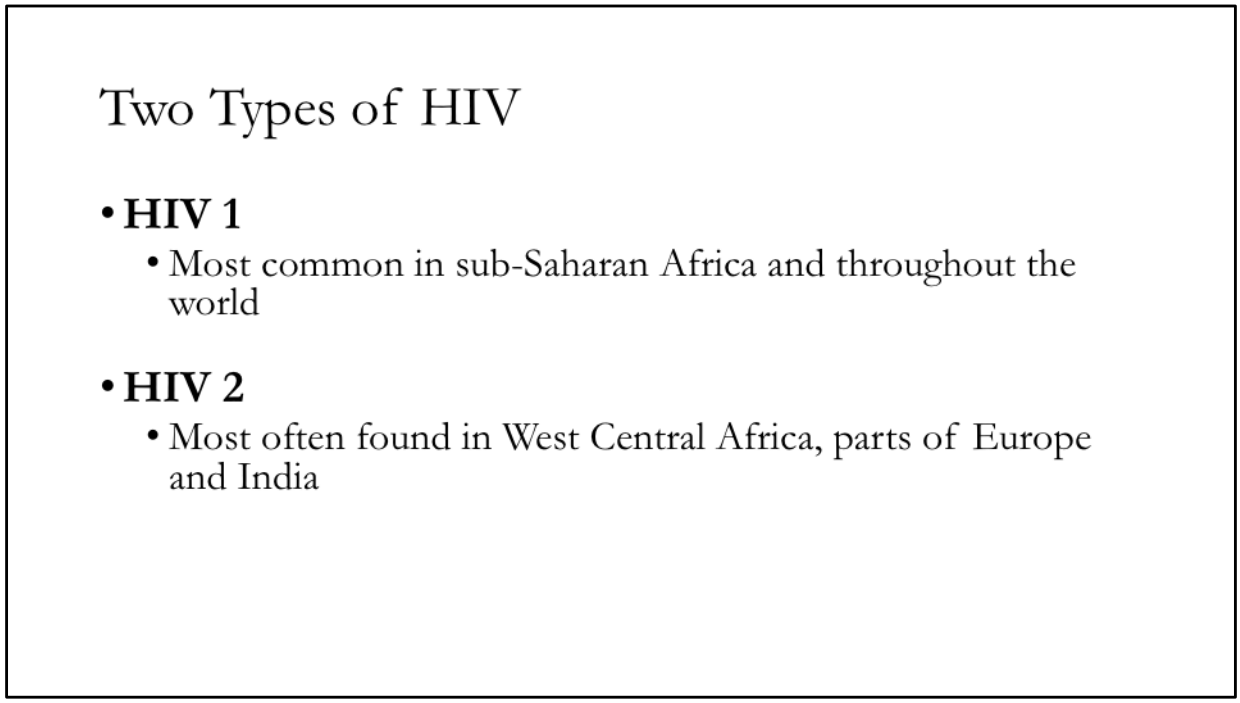


Here is a clearer map by country

What does prevalence rate mean? (if prevalence is the total number infected, prevalence rate is the number infected divided by the total population).


Epidemic in sub-Saharan Africa, 1985–2003
Millions
Number of people living with HIV and AIDS
% HIV prevalence, adult (15–49)
Number of people living with HIV and AIDS
% HIV prevalence adult (15–49)
0
5
10
15
20
25
30
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
Year
Source: UNAIDS/WHO, 2004

Questions?



Both produce the same patterns of illness. HIV2 causes a more slow progress of disease than those with HIV 1.

Because HIV like other viruses is so quickly mutating, its possible to track the infection by examining the strain of HIV itself.

This isn't particularly important for the sake of this class, but I introduce it because this is not what I am talking about in the next question…

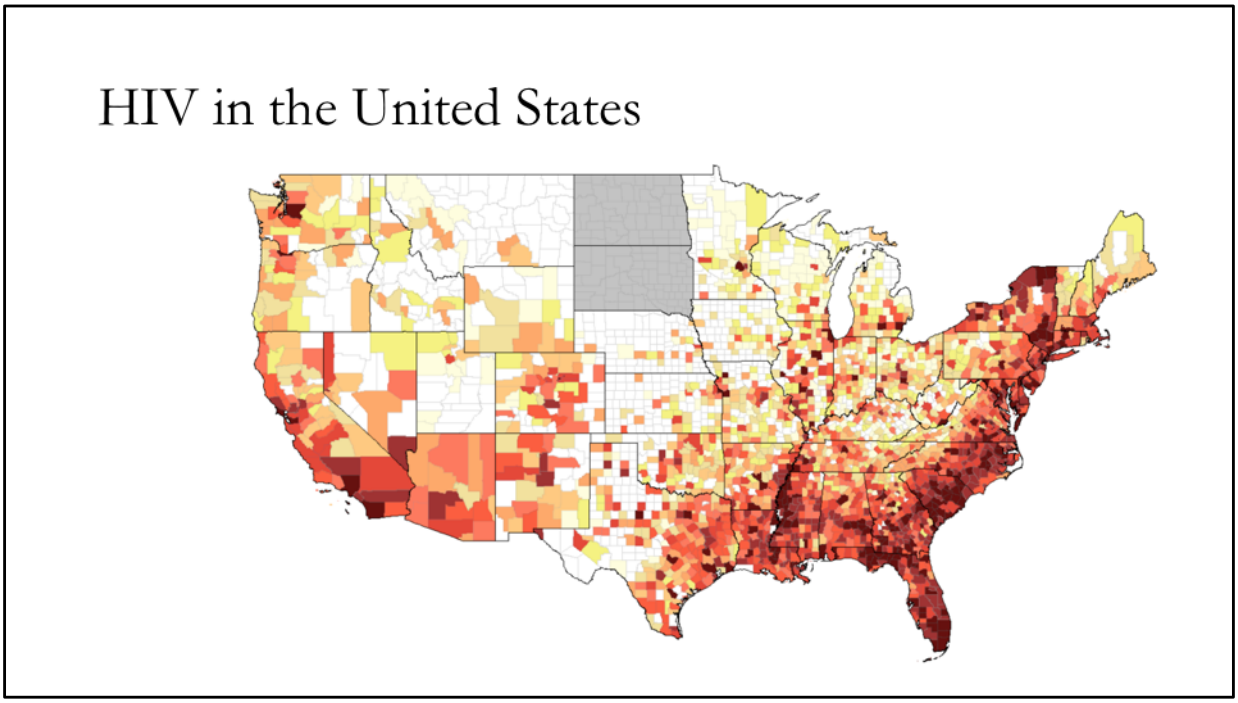
Multiple HIV Epidemics

- **How is the HIV epidemic spreading and amongst what populations?**

Some people argue that HIV is spreading in multiple global epidemics.

One amongst heterosexual people in predominantly poorer countries (think Africa, India, etc.). One amongst IV drug users (centered in Eastern Europe) and one amongst homosexuals (centered in the US and Western Europe).

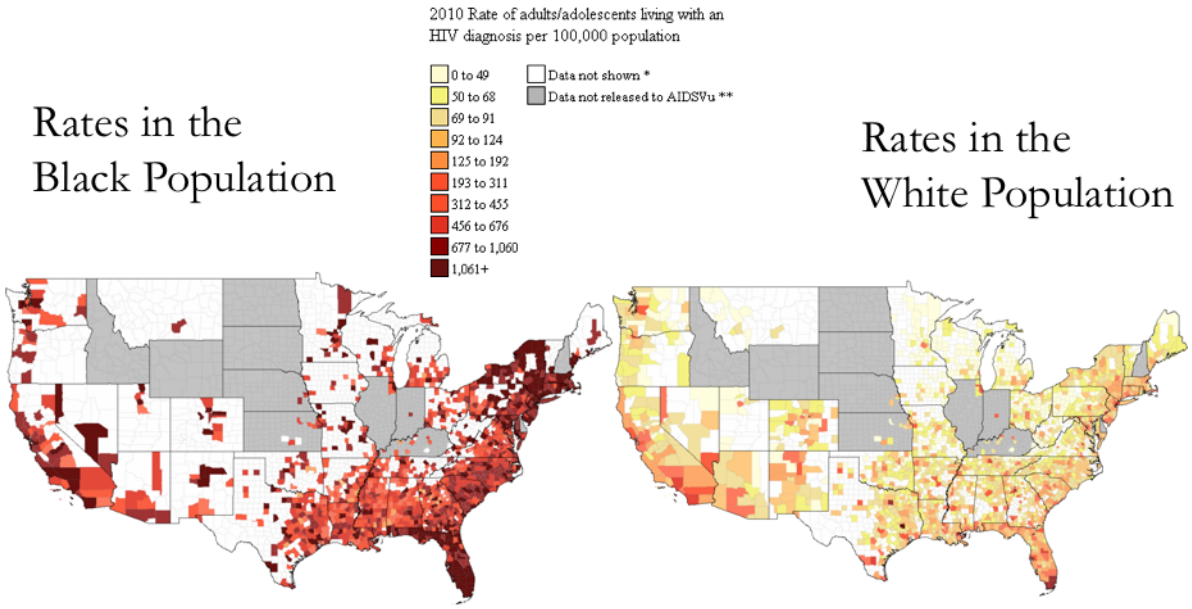
And what type of epidemic is happening in the US? (initially homosexuals, but is now increasingly affecting heterosexuals of particular demographics).



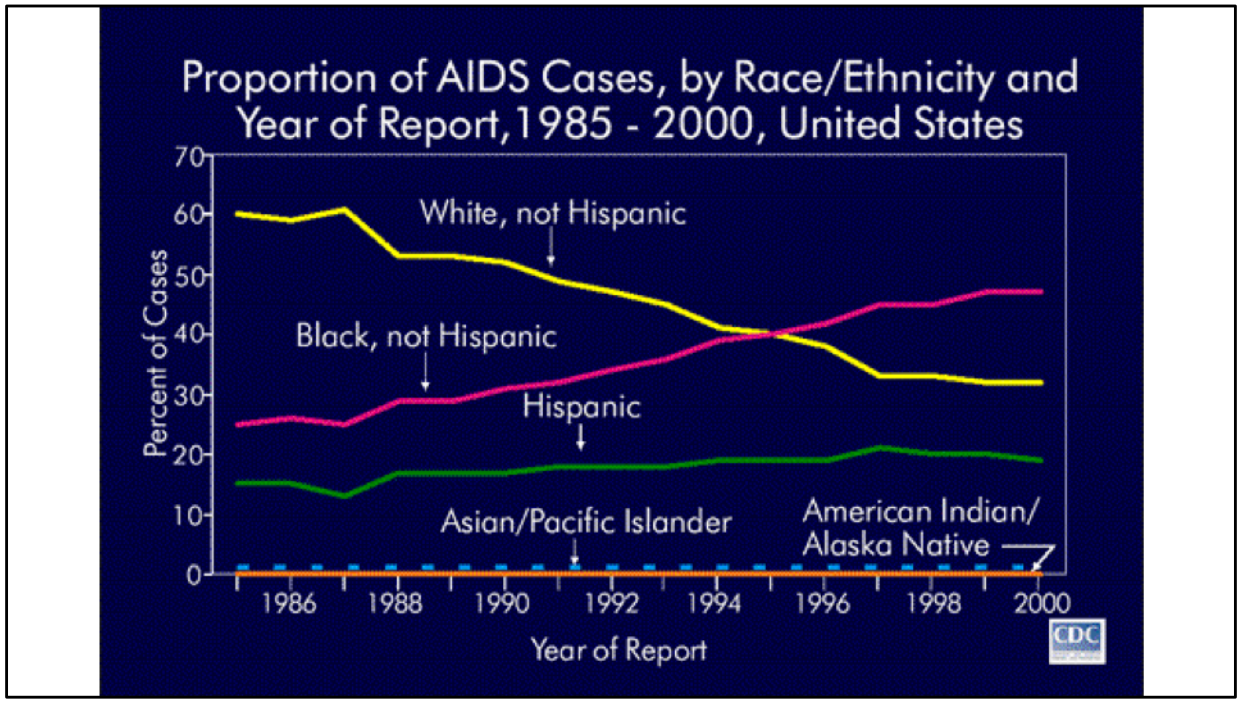
Data from AIDSVu

Map of prevalence rate of HIV

Rates in the Black Population



Rates in the White Population


Proportion of AIDS Cases, by Race/Ethnicity and Year of Report, 1985 - 2000, United States
Percent of Cases
70
60
50
40
30
20
10
0
White, not Hispanic
Black, not Hispanic
Hispanic
Asian/Pacific Islander
American Indian/ Alaska Native
1986
1988
1990
1992
1994
1996
1998
2000
Year of Report
CDC

What population factors influence the spread of HIV?

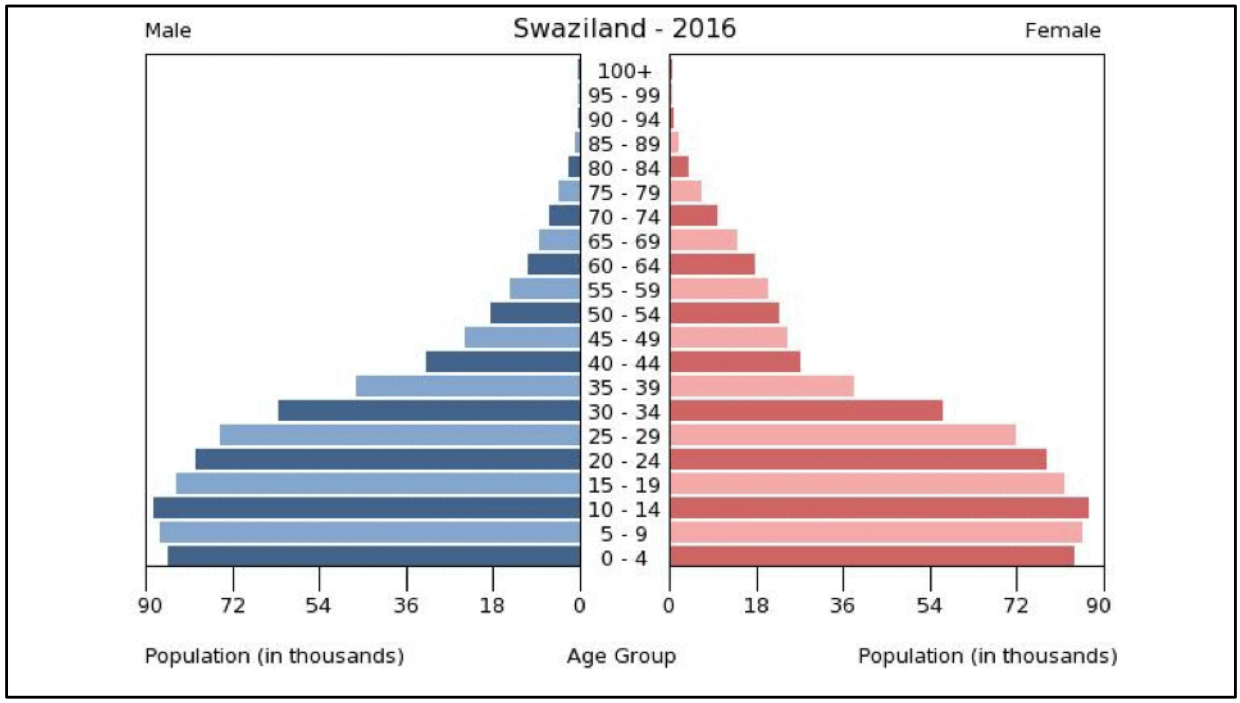
What population factors influence the spread of HIV?

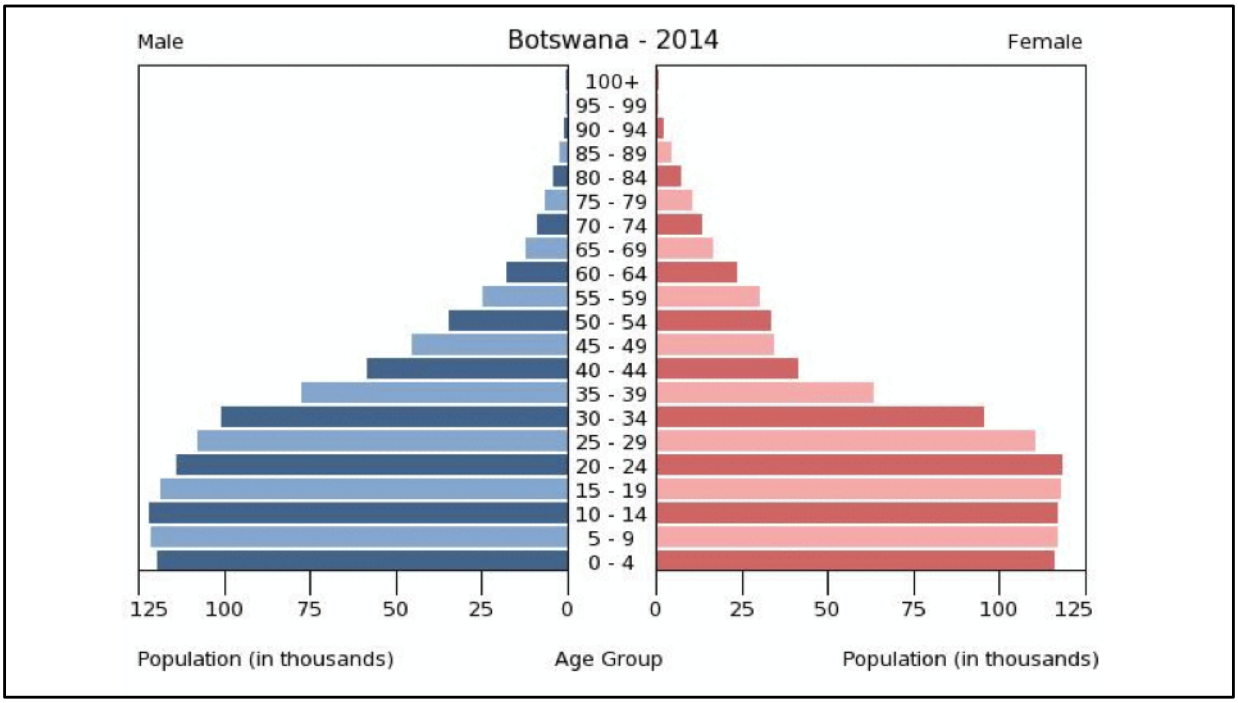
- Previous HIV levels in the population
- Poverty, education levels
- Maternity rates, motherhood practices
- Other diseases in the population
- Male-female ratios

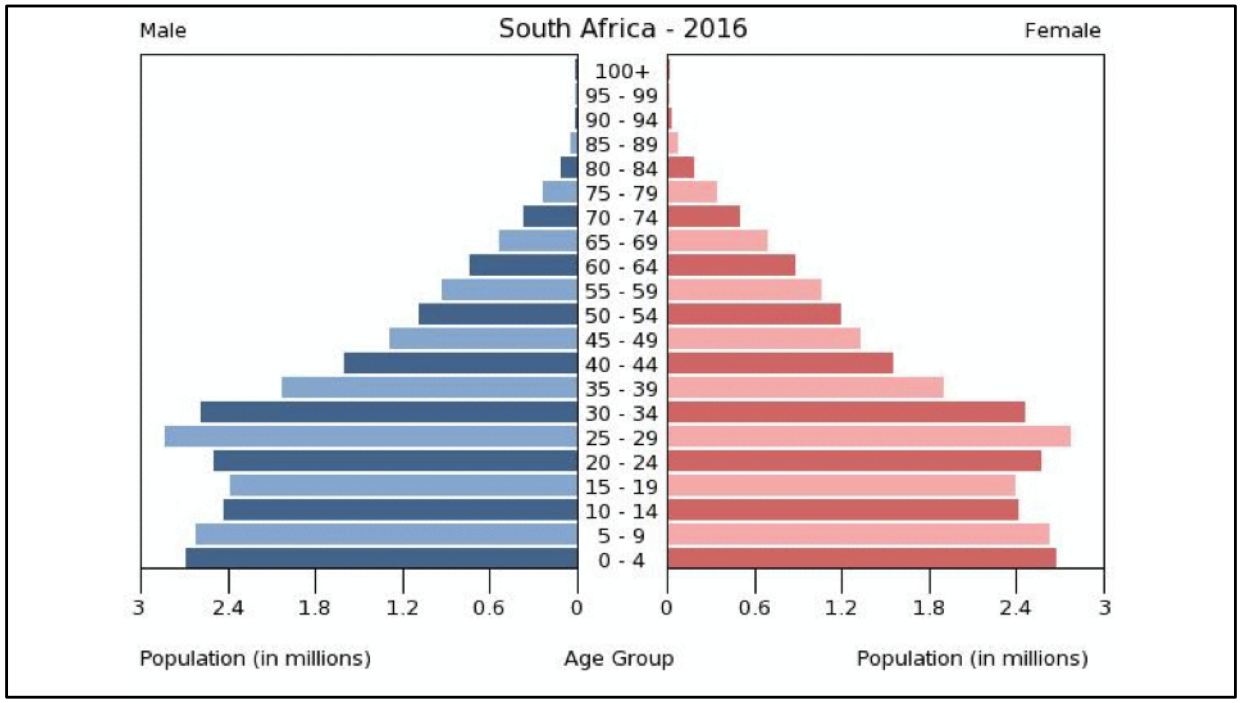
Questions?

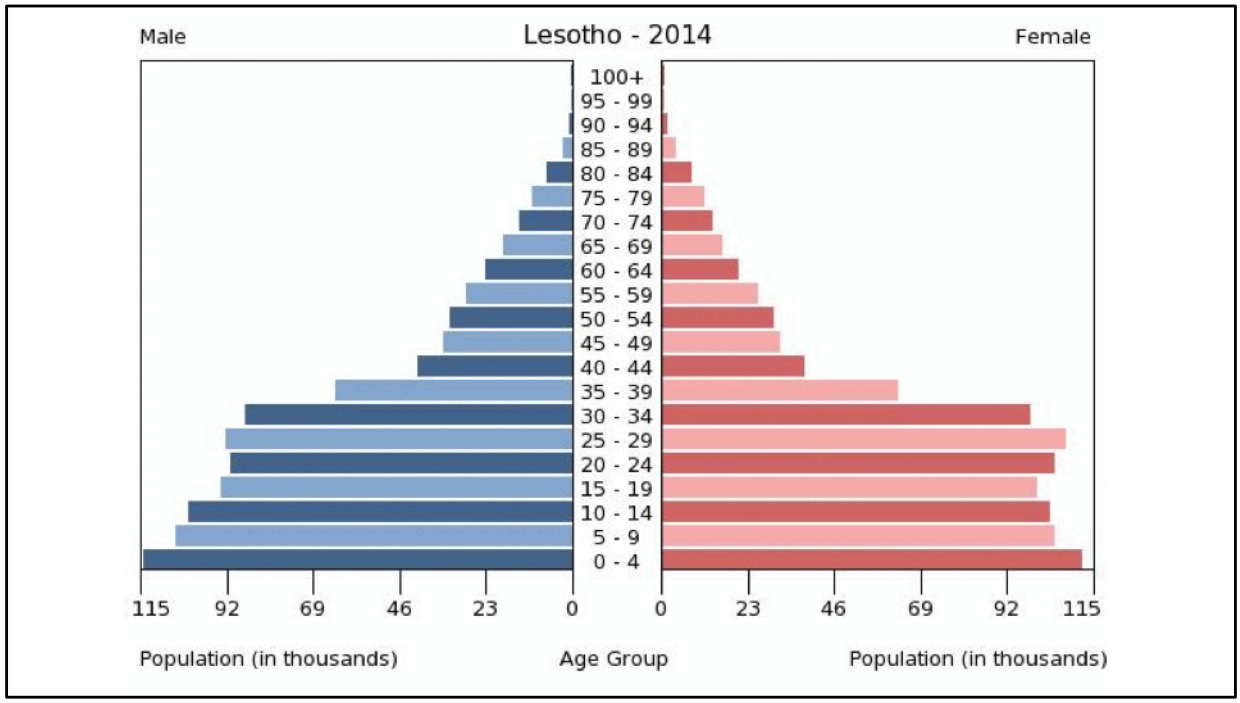
So, based on what you know of HIV/AIDS, what would you expect the population pyramid of the most highly infected countries to look like?

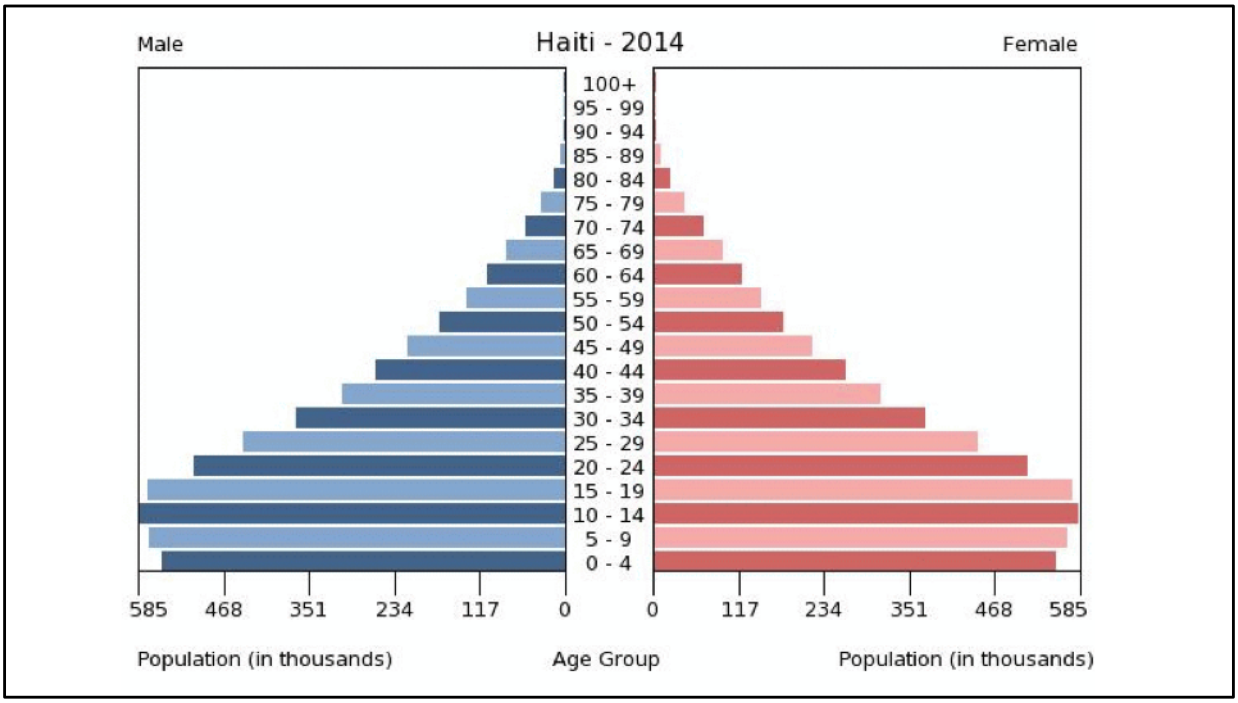
Take a few minutes with your neighbors to discuss.


Swaziland - 2016
Male
Female
100+
95 - 99
90 - 94
85 - 89
80 - 84
75 - 79
70 - 74
65 - 69
60 - 64
55 - 59
50 - 54
45 - 49
40 - 44
35 - 39
30 - 34
25 - 29
20 - 24
15 - 19
10 - 14
5 - 9
0 - 4
90 72 54 36 18 0
0 18 36 54 72 90
Population (in thousands)
Age Group
Population (in thousands)


Botswana - 2014
Male
Female
100+
95 - 99
90 - 94
85 - 89
80 - 84
75 - 79
70 - 74
65 - 69
60 - 64
55 - 59
50 - 54
45 - 49
40 - 44
35 - 39
30 - 34
25 - 29
20 - 24
15 - 19
10 - 14
5 - 9
0 - 4
125 100 75 50 25 0
0 25 50 75 100 125
Population (in thousands)
Age Group
Population (in thousands)


South Africa - 2016
Male
Female
100+
95 - 99
90 - 94
85 - 89
80 - 84
75 - 79
70 - 74
65 - 69
60 - 64
55 - 59
50 - 54
45 - 49
40 - 44
35 - 39
30 - 34
25 - 29
20 - 24
15 - 19
10 - 14
5 - 9
0 - 4
3
2.4
1.8
1.2
0.6
0
0
0.6
1.2
1.8
2.4
3
Population (in millions)
Age Group
Population (in millions)


Male
Lesotho - 2014
Female
100+
95 - 99
90 - 94
85 - 89
80 - 84
75 - 79
70 - 74
65 - 69
60 - 64
55 - 59
50 - 54
45 - 49
40 - 44
35 - 39
30 - 34
25 - 29
20 - 24
15 - 19
10 - 14
5 - 9
0 - 4
115
92
69
46
23
0
0
23
46
69
92
115
Population (in thousands)
Age Group
Population (in thousands)


Haiti - 2014
Male
Female
100+
95 - 99
90 - 94
85 - 89
80 - 84
75 - 79
70 - 74
65 - 69
60 - 64
55 - 59
50 - 54
45 - 49
40 - 44
35 - 39
30 - 34
25 - 29
20 - 24
15 - 19
10 - 14
5 - 9
0 - 4
585 468 351 234 117 0
0 117 234 351 468 585
Population (in thousands)
Age Group
Population (in thousands)

Questions?