Mortality, Morbidity and Health

Distribute Mortality Handout #1

Covered briefly previously the large increase in the world population from the 18th Century to today is due to the demographic transition.

Both mortality and fertility decline but mortality declines earlier and faster than fertility. This results in large population growth.

From now on, we are going to study why mortality and fertility decreased. We start today with mortality.

This week we will focus on the experience of industrialized nations during the 19th and 20th Century.

Next time we will look at the experience of less developed countries during the second part of the 20th century.

Remarks about Mortality

Mortality – death
Morbidity – disease where or not leads to death
Together they measure the health status of the population.

Two populations with same level of \( e_0 \) could have quite different health statuses – but overall relatively close (good) relationship (especially in the past).

There is evidence showing that when mortality declines morbidity levels decline as well.

Here we focus mostly on mortality rather than morbidity.

Old tradition in demography – more interested in mortality because it has implications for population size, population growth, and population age structure.

But keep in mind that mortality is an imperfect (incomplete) picture of health status of a population.

Some people prefer to measure “healthy life expectancy”. Problem with health measures: health/diseases are more difficult to measure than deaths (not as well recorded [hospital based]). Also more difficult to define: distinction between healthy/non-healthy not as clear cut as for dead/alive. When does a disease start to make an individual “unhealthy” – some arbitrariness when computing “healthy life expectancy.”
Unlike fertility reduction of mortality is a universal goal. The preference for lower mortality is universal – not cultural.

Fertility is more complex. Preference for fewer children not as universal as preference for longer life.

DESCRIBING MORTALITY CHANGE

Western Mortality Transitions

Why did mortality start to decline in the 18th Century? What are the main factors?

Let’s start with the facts.

[chart e₀ Sweden; England Wales, page 2 of handout]

1. Pretransition Mortality (pre-1700)

Life expectancy in pre-historic times e₀ = 20 years.

Evidence: skeletal remains and burial records.

Estimates supported by demographic models of population growth.

Note again: low e₀ does not mean that most people die at age 20. Many deaths < 5 and > 50 so on average life expectancy is 20. If you survive past the first 5 years, likely that you will survive through adulthood. Not unusual to old people in high mortality settings.

1500-1600
First data available; e₀ rarely above 35-40.

Pre-transition mortality characterized by wide fluctuations. Due to war, famines, epidemics.

2. End of Mortality Crisis (1700-1850)

The first step in mortality improvements is the reduction in the magnitude and frequency of crises – but little improvement in the life expectancy (stays below 40-45 years)

[show charts, pages 3 and 4 of handout]

- war
  - less conflict
  - less mortality from conflict
- famines
  fewer famines b/c
  better transportation/storage
  less price fluctuations
  migration as a response to famines (cf. Ireland)

- better crops
  potato
  improvement in cultivation techniques – less affected by environmental disasters, climate fluctuations.

- Growth of administrative influence to relieve famines
  End of mortality crises coincide with the beginning of central states

- epidemics
  why did they stop? Not fully understood. Increased host resistance due to improvements in nutritional status (link between nutrition and immune status). Changes in the genetic make-up of infectious diseases.

  Accommodation between humans and agents of infectious disease. Some public health (isolation of infected individuals etc.)

  [show chart Vallin and NYC, page 4 of handout]

3. Large increases in $e_0$

  $e_0$ from 40-45 to 70 (1850 – 1950)

  Reductions in infant mortality are the most important. Rapid improvements especially after 1900. Minor changes in old age mortality.

4. Declines in old age mortality (after 1950)

  $e_0$ 70 to above 80
  Reduction mortality at older ages as well.

  [show chart] reduction by age, {Beyond 6 billion} page 5 of handout

  Distribution of deaths completely different before/after transition

  [show chart Shiro] page 6 of handout

**Three Broad Causes of Death** (causes of death impact for underlying mortality change)

Main cause of death
Group 1 Communicable diseases
Infectious and parasitic diseases

When individuals are killed by diseases that can be transmitted from one person to the other (due to micro organism)

Virus (noncellular organism) or Bacteria (single-celled organism)

Example:
- Malaria
- Plague
- Smallpox
- Measles
- HIV/AIDS
- Pneumonia and influenza
- Tuberculosis
- Diarrhoeal diseases

Classification of communicable diseases according to mode of transmission

- airborne (influenza/pneumonia, TB, smallpox, measles, etc)
- water-food-borne (diarrhea, typhoid, cholera)
- vector-borne (malaria, typhus, plague)
- sexually-transmitted diseases (HIV/AIDS, syphilis)

Other diseases also included in this category (WHO-Group 1)
Maternal – perinatal deficiencies
Nutritional deficiencies

Group 2 Non-communicable diseases
Degenerative diseases
Chronic diseases

In this case the cause of disease is not so much due to external factors, but to internal factors. Refers to the biological deterioration of the body.

These diseases are:
- more difficult to detect than infectious diseases
- non-contagious origin
- multiple risk factors
- long latency period
- long duration of illness (associated with disability)
- more difficult to cure than infectious diseases

Examples:
- cardio-vascular (coronary heart disease) ischemic heart disease
- cerebrovascular disease (stroke) loss of blood flow to the brain
- cancer (neoplasms)
- chronic lung disease (find details for next years)
- diabetes mellitus
- chronic liver disease (if cirrhosis related to alcohol)

**Group 3 (Injuries – external injuries)**

For this group the death is not due to disease but to injuries
The individual is typically in good health at the time of the injury.

- Accidents
- Homicide
- Suicide

Typically not major cause of death relative to other causes, both before and after epidemiological transition (except may be of hunting and gathering societies)

**The Epidemiological Transition**

The idea that changes in $e_0$ are associated with changes in cause of death
(descriptive not explanatory framework)

Several transitions – but the most important is from infectious to degenerative disease.

Before mortality decline mostly infection after transition mostly degenerative (man-made diseases [alcohol, tobacco, suicide, traffic accidents])

[show chart from Shito] page 5 of handout

Decline in infectious diseases responsible for the largest part of mortality decline during the 20th century. Especially TB.

Cardio-vascular diseases become the most important disease.
Today, cardio-vascular diseases is the lead cause of death in the US

{Horiuchi} talks about a new phase of the epidemiological transition
Decline 1970 on Cancer becomes more important (not in US but in Europe)
1990s – cancer starts to decline

Concept of epidemiological transition useful
Less developed countries seem to follow the same path (communicable and non-communicable diseases)

But be careful – reverse transitions. Framework doesn’t explain:
New Epidemics (HIV/AIDS)
Former Soviet Union
What are the most important factors accounting for mortality decline and the shift from infectious diseases to non-communicable diseases?

**Framework for Understanding Mortality Change**

Before looking at the factors, let's examine a framework for understanding mortality change.

(Next year remove handout with factors come up with the list of possible factors with students)

Factors explaining mortality decline can be classified in these three categories: (a) degree of exposure to agents of disease; (b) degree of resistance to agent of disease; (c) lethality of disease.

(Be brief – need only for discussion on McKeown) exposure*resistance*recovery

- Degree of exposure to agents of disease (put at risk for disease)
- Degree of resistance to agents of disease (determines whether get disease)
- Lethality of disease (determines survival)

Example for infectious diseases
Exposure: a given population in an area experiences a level of exposure or contact with organisms. Related to community, household and individual characteristics (climate, quality of water, household hygiene)

Resistance:
If one comes in contact with the organism then the assault on human host will depend on immunological resistance (how your immune system resists): natural and acquired.

Lethality:
If disease strikes recovery depends on ability to recover: natural and acquired (medication/treatment)

Reduction in mortality is a complex issue operates at these three levels which affect the transition from healthy to dead.

Another dimension is the distinction between factors operating at the micro level and those operating at the macro-level.

Micro dimension: individuals and household level
Mortality levels affected by what individuals do (personal behavior)

Macro: community variables
Mortality levels affected by what governments (local/national) do
Infrastructure (hospitals, water supply, sewage, etc.)

Let’s list factors associated with mortality levels and trends according to these two dimensions:

<table>
<thead>
<tr>
<th></th>
<th>Community</th>
<th>Household/Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure</td>
<td>Altitude/climate</td>
<td>Housing quality</td>
</tr>
<tr>
<td></td>
<td>Density/crowding</td>
<td>Hygiene</td>
</tr>
<tr>
<td></td>
<td>Infrastructure (sewage, water supply, transportation)</td>
<td>Diet/nutrition</td>
</tr>
<tr>
<td></td>
<td>Pollution</td>
<td>Behavior</td>
</tr>
<tr>
<td></td>
<td>Medical technology</td>
<td>(tobacco, alcohol, exercise)</td>
</tr>
<tr>
<td></td>
<td>Knowledge (collective)</td>
<td>Information</td>
</tr>
<tr>
<td>Resistance</td>
<td>Virulence of micro-organism</td>
<td>Genetic factors</td>
</tr>
<tr>
<td></td>
<td>Medical technology</td>
<td>Use/access to medical facilities</td>
</tr>
<tr>
<td></td>
<td>Existence of medical facilities</td>
<td>Compliance/diet</td>
</tr>
<tr>
<td>Recovery</td>
<td>Medical technology</td>
<td>Genetic factors</td>
</tr>
<tr>
<td></td>
<td>Existence of medical facilities</td>
<td>Use/access to medical facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compliance/diet</td>
</tr>
</tbody>
</table>

Michel not pleased with classification from last time p.10 States: distinguish between the different actors of mortality decline list only those that can change over time.

**Causes of Long Term Mortality Decline in Western Countries**

Which of these factors were key in explaining mortality in industrialized countries. 19th and 20th century? (article by Schofield and Reher provides good summary)

Let’s start with the work of McKeown.

**The Work of McKeown**

Very influential in studying mortality change.

Two important books:
- The Modern Rise of Population (grads)
- The Role of Medicine (all)

Two things to remember about McKeown:
- argued that medicine had a small role in mortality decline in Europe. Widely accepted conclusion.
- Argued that improvement in nutrition is the most important factor. Widely rejected conclusion.
  How did he come to this conclusion?
He examined different explanations for mortality decline, using the exposure/resistance/recovery framework described earlier focusing on communicable diseases.

(Talk about exposure*resistance*recovery framework here)

**Potential factors**

1. Autonomous decrease in the virulence of micro-organisms.
2. Improvements in exposure (less exposure to micro-organisms)
   - Public health measures (sanitation, hygiene)
   - Immunization (immunization of people reduces overall exposure)
3. Improvements in resistance
   - Direct intervention – immunization (medicine)
4. Improvements in recovery
   - Effective scientific methods to treat illness (medicine)
   - Better ability of individuals to recover from infectious (better immune response) because of nutrition

Then he looked at the most important causes of death responsible for the mortality decline, and examine which factors 1-4 are consistent with such declines. (data from Britain – 1840 onwards)

He proceeds by **elimination** – the cause that couldn’t be ruled out must be the explanation.

The main cause of death responsible for declines are air-borne (40%), especially TB (17.5%) (these are the ones that are most difficult to control with public health measures such as sewage, safe water).

[chart table 3.1 and 32 from Modern Live of Ap] page 7 of handout

He looked at the different explanations see if they are applicable to air-borne diseases and TB in particular.

- Decrease in virulence: No. TB as virulent today as in the past.
- Medical knowledge: No. main contribution of his work, operates at different levels. Exception small pox and diphtheria

[show chart TB from readings]

[chart other factors] page 8 of handout

Medicine played a more important role later on (last 50 years) but not in the 19th Century.

- Public health and personal hygiene
Important public health measures taken after 1850 (sewage, wage, sanitation), but mortality started to decline earlier.

Useful mostly for water-borne diseases. Not so much for air-borne diseases.

TB unaffected by these measures.

What’s left as an explanation? Better recovery from diseases (better immune response) Attributes this better recover to better nutrition.

{Schofield and Reher} “McKeown has placed economic and nutritional factors at the center stage of mortality improvement.”

According to him: public health, sanitation, government/states do not play a major role. Policy implication: economic development (increases in standards of living, income) more important than public health measures.

His conclusions have been challenged since the publication of his books.

More nuanced interpretation of mortality decline {Schofield and Reher}

Very laissez faire approach; governments should not interfere much with individuals.

Implication: an adequate diet is the most important vaccine against infection.

**Evidence Against McKeown**

Objections:

McKeown provided no evidence for improvements in nutrition levels (actually some researchers argue that nutritional status declined in the late 19th century). Conclusion reached by default, by process of elimination.

McKeown did not study the link between nutrition and infection. Complex interactions (nutritional status decreases during an infection, regardless of food intake, the body is less able to metabolize food) when improvements in nutritional status could be the consequence of decreases in infections, rather than the other way around.

Nutrition = food intake
Nutritional status = amount of food that is metabolized by the body.

**Other Evidence**

1. **The Aristocracy** [chart page 10 of handout]
Aristocracy had much better nutritional status and standard of living/housing etc than the rest of the population.

However, the life expectancy of the aristocracy was very close to that of the rest of the population.

Their survival rates improved before the rest of the population, whereas presumably their nutritional status didn’t change much (it was good before and after mortality change).

So nutrition cannot be the whole story. There must be some external factors at play as well.

Certainly it is the exposure to disease more than resistance (through nutrition) that makes the case for the aristocracy.

**Fogel**

Inspired by McKeown. Provides constructive evidence on nutrition and effort. Makes case for the interaction between nutrition, physiology and economic growth. He had just started the project when I worked for him as a graduate student 25 years ago.

The reading is his Nobel lecture; provides a summary of his research agenda. Book published in 2004 *Escape from Hunger and Premature Death, 1700-2100*.

In 1970s and 1980s the debate was whether the mortality decline was due to the elimination of mortality crises (related to famines). Scores of local studies especially for England and France. Showed that 90 percent of the secular decline in mortality was due to the reduction of “normal” mortality.

This led the way to studies of the role of chronic malnutrition as the principal pathway through which malnutrition contributed to high mortality rates of the past.

Malnutrition either because of inadequate diet or by claims on that diet (by work and disease) so great as to produce malnutrition despite a nutrient intake that in other circumstances may be adequate.

Before middle of 19th century – food production so low that poorer classes were bound to have been malnourished.

Performs basically an accounting exercise – one that is complicated because most sort out direct effects, indirect effects, and interactions.

The key analytical idea is that people who experience chronic malnutrition for long periods of time are stunted (shorter).
Today the typical American male in his early 30s is about 177 cm (69.7 inches) and weighs about 78 kg (172 pounds). He needs about 1800 calories for basal metabolism (energy required to keep the body functioning while at rest) and about 2300 calories for baseline maintenance (basal + energy for digestion of food and vital hygiene).

Calorie intake in Britain circa 1790 was about 2000 calories per capita or about 2700 calories per adult male equivalent. France 1781-1790 2290 calories and 2410 calories in 1803-1812 (Napoleonic Wars) again for adult male equivalent.

To produce the national products in these countries population had to be small and light.

[show table 1 p. 372 p. 13? In handout]

4th quarter 18th century Britain 167.9 cm or 66 inches (5’ 6’’) weight 61 kg (134 pounds)
4th quarter 18th century France 163.0 cm or 64 inches (5’ 4’’) weight 50 kg (110 pounds)

Note these are average heights so the poor had to be even shorter.

Studied the size distribution of caloric consumption.

1790 – France bottom 10 percent of labor force lacked energy for regular work, next 10 percent had enough energy for less than 3 hours of light work (and about 1/2 hr of heavy work).

1790 – England things are a bit better. 3 percent didn’t have enough energy for any work, and the bottom 20 percent had enough energy for about 6 hours of light work (1.1 hour of heavy work) each day.

Height by age and weight for height (BMI) are effective predictors of the risk of morbidity and mortality.

Height – a net measure of nutrition (reflects the accumulation of past nutrition). Adult final heights reflect not adult levels of nutrition but the nutritional levels during infancy, childhood and adolescences.

Weight for height – primarily the current nutritional status. Also net (balance of current intake and the claims on that intake).

Relationship between Body Size and Risk of Death at Middle and Late Ages

[Show Figure 3 from Fogel – Relative mortality by BMI] BMI = weight/ht^2 (kg/m^2)

See the u-shape with mortality (between ages 50-64) minimized at about 25.

[Show Figure 4 from Fogel – Waaler curve] Iso-mortality curves by weight and height.
The Solid dark line is the minimum risk curve – it is the combination of weight and height that minimizes the mortality risk.

Dotted lines – iso-BMI curves. (16-34), > 25 obese, > 30 clinically obese
Solid (lighter lines) iso-mortality curves (0.7-2.2) where 1 reference

Can calculate your BMI and use weight or height to determine mortality relative mortality risk.

Superimposed the French Population height and weight from 1705 through 1975.

In 1705 ht is about 1.61 meters weight is about 45 kg relative risk is about 1.8.
By 1785, slightly heavier, risk decreased to about 1.7. By 1870, fallen to 1.2. By 1975 risk is 1, and near mortality minimizing level.

Gain in BMI accounted for most of the predicted reduction in the risk of mortality before 1870. After 1870, factors associated with gain in height explain most of the predicted mortality decline.

Together the factors account for about 90 percent of the actual decline in French mortality 1785-1870, but account for only 50 percent of the actual decline in the past century.

Punchline: Equilibrium – numerous levels at which population and food supply can be in equilibrium, however, some levels will have smaller people and higher “normal” (non-crisis) mortality than others.

Increased production of food permitted an improved diet and nutrition. Allowed people to work more intensely and for more hours. Increased productivity. Plus, health improvements and the decline of infectious diseases gave an additional boost, as less energy was devoted to fighting infections – more available for work.

2. The Role of Public Health

Two important articles make the case of public health.


S. Preston and E. van de Walle (graduates) Urban French Mortality in the 19th Century.

Szreter argues that sanitation measures (sewage systems, water supply), especially at the local level (municipalities), were neglected by McKeown. For Britain important sanitation measures were taken early on and potentially have an impact on mortality.
Example: Cholera in Hamburg impressively reduced after building sewage system in the late 19th Century. (Remember: Cholera is a water borne disease.)

Preston and van de Walle make a similar case for France. They look at three cities Paris, Lyon, and Marseilles. Differentials between the cities and the evolution of these differentials over time correspond with change in water/sanitation. (Improved sanitation increased survival)

3. Role of Personal Behavior

Cf. Preston and Haines “Fatal Years” An important book using materials from 1900 US Census. They applied new demographic techniques to old data.

They looked at child survival around 1900 in the US.

Evidence/facts:
1. Child mortality still high relative to standard of living and level of nutrition (which are OK in the US by 1900). Food was abundant and relatively cheap. Mortality high (check to see how high). Today it would be among the high mortality countries.

2. Better survival in rural areas in spite of lower standard of living. Evidence for the importance of exposure. Importance of population densities for disease transmission. E.g., $e_o$ 48 (urban) 55 (rural) for white female 1900-02.

3. Social differentials not very large. They became larger later on. In 1900, more privileged groups were not able to achieve much lower mortality. Better income doesn’t help that much. Also, small link between education and mortality.

[chart differential, see physicians] page 13

4. High seasonality of deaths. External factors seem to play a large role.

[chart seasonality] nb. Greater risk of food contamination during summer page 14 in handout

These facts tend to show that income/standard of living not necessarily the most important factor.

People were motivated to improve child survival, sometimes had the necessary resources, but the knowledge was simply non-existent. IGNORANCE.

Germ theory developed in 1860 by Louis Pasteur. Demonstrates the existence of micro-organisms which are agents of disease and the possibility of different modes of contamination that are not necessarily visible.
Slow acceptance of theory after 1900.

Old theory: miasma theory. Agents of disease are transmitted by dirt (filth). Odor and appearance was thought to important factors. Sometimes led to effective measures/interventions (sewage systems and water purification).

Importance of social programs early on and under estimated by McKeown.

Practice of medicine: no major impact (agrees with McKeown) until after WWII. Sometimes, going to hospital actually increased the risks (because of greater transmission of disease via infections if hospitals not clean).

Health knowledge still not existing.

After 1900 Germ Theory became more accepted. Knowledge of germ theory diffused at the household level and translated into personal hygiene behavior.

Here knowledge means common (widely accepted) practices:
- Washing hands/overall personal hygiene
- Washing/changing clothes often
- Household hygiene
- Sterilizing milk by boiling it
- Sterilizing bottles for feeding babies (breast-fed kids had better survival rates)
- Protecting food from flies and other sources of contamination
- Isolating sick family members

These are the factors which, together with public health measures led to large mortality reductions after 1900.

Improvement in scientific knowledge can lead to many innovations besides those in medicine.

Importance of health education (strong link between social/public health programs and personal behavior)

Importance of changes in mentalities – belief that parents can do something to improve the survival of their children. Very important aspect with important consequences for personal behavior.

This change in mentalities (more investment in children) goes together with sending their children to schools rather than having them work.

Policy implication: More interventionist approach – focus on a macro-level role of social organization, public health measures (water supply, household sanitation, diffusion of medical knowledge)
Once knowledge and technology exist then social differentials/education play a more important role for survival (cf. Increasing social differentials over time)

We can translate your higher education into better health now, but not the case during the 19th Century. (But is knowledge or personal traits)

Key point: several factors at play – not only one explanation {Schofield and Reher} No simple road to mortality decline.

**Chronology of the most important factors associated with mortality decline in Western Countries** (from Preston and Haines)

**Mortality improvements before 1900** (slow improvements)

- Some role for better standards of living (better nutritional intake and improved resistance to some infectious diseases). Some role but not the only factor.
- Various public health measures (sewage and water supply) sometimes based on erroneous theories
- Limited role of medicine (except for the inoculation against smallpox/diphtheria)

**Mortality Improvements after 1900** (Rapid improvement)

- Personal behaviors, resulting from better knowledge about diseases (acceptance of germ theory)
- Drug based therapies (after 1930)

**Mortality Improvement after 1950** (gains concentrated among the elderly)

- Knowledge of risk factors (smoking, diet, exercise, alcohol)
- High-tech medicine for heart disease and cancer

We will look at future steps in mortality decline in a couple of weeks. Is there a limit to life expectancy? Also, we’ll look at why there are mortality differentials in today’s more developed countries (not everyone is equal).

Next Week:

- Mortality in developing countries
- Different situation: medical knowledge widely available at the time when developing countries start their mortality decline.

Questions include, medical knowledge:

- Impact on speed of mortality decline?
- Impact on reason for decline?
- Impact on today’s mortality differentials across countries and within countries?
- What are the policy implications?
Mortality in Less Developed Countries (LDC)

This week [page 1 of handout #2 on mortality -- outline]

1. Mortality in LDC
2. Reasons for mortality decline (not like in MDCs)
3. Differentials
   a. Why some countries have better mortality than others?
   b. Why within LDCs so some individuals have better mortality than others?
4. Policy issues: what to do for better health improvements (skip)
5. New Infectious diseases/AIDS

One word about data (for developing countries):
   Much less is known – infant mortality pretty well known, because survey methods allow to estimate mortality at these ages (lack of census/death registration in many countries)
   Much less is known about adult mortality (more difficult to measure in surveys)
   Also cause-of-death data largely missing – use of methods to estimate mortality by cause in less developed countries

Always be more cautious when you see detailed mortality data from LDCs

1. Patterns of Mortality Change in LDC:

Mortality decline in LDCs: very important improvements after 1950
Much more rapid decline than in MDCs {Preston}

[slide comparison MDC – LDCs declines]

Example: this slide – slopes much steeper than for Sweden

India:
   1952: \( e_0 = 38.7 \)  \hspace{1cm} 1997: \( e_0 = 62.3 \)  \hspace{1cm} gain of 23.6 years

Senegal:
   1952: \( e_0 = 36.5 \)  \hspace{1cm} 1997: \( e_0 = 52.3 \)  \hspace{1cm} gain of 15.8 years

In 45 years same improvements as in Sweden from 1820 to 1900 (80 years).

Argentina : Not so rapid today as mortality decline started earlier.

Although these data put all developing countries together, in reality the situation is very different depending on the country.
What are the patterns of changes in the causes of death?

These countries are at different stages of the health transition, they all follow the same pattern as in MDCs. (epidemiological transition).

Almost all of the mortality decline is due to decline in infectious diseases, as in MDC in the past.

[chart top page 4] – developing countries in top graph from 1950. Sweden’s pattern e₀ much the same as England and Wales from Page 2.

Look at next page [page 5, B6B 5.1]

We can distinguish 3 groups of countries

**Early transition**
- Low mortality today – started transition more than 70 years ago (before WWII).
- This includes much of Latin American and the Caribbean.

**Delayed transition**
- Medium mortality today – started transition 55 to 70 years ago
- Countries scattered throughout the world
  - Brazil
  - China, India, Indonesia
  - North Africa, Turkey, Middle East
- Very rapid transition

**Very Delayed transition**
- High mortality today – started transition less than 55 years ago
- Life expectancy at birth is low e₀ < 55 years.
- Progress slower today with HIV/AIDS, see declines and slowdown in e₀.

Be careful when discussing LDCs – very heterogeneous group of countries, with great variability of mortality (much more variability than in MDCs). Variability true for other measures as well, such as per capital income etc.

Example: child mortality

[chart from WHO child mortality] page 7 of handout

Great variability – both in speed of the decline and in the level of differentials today. See large difference among developing countries – Africa the worst by a large measure.

**Cause of deaths today in LDCs**

What are the most important cause of death today in LDCs?
This chart shows that infectious diseases are the most important cause in Africa. Shows that LDCs are not as advanced in the epidemiological transition as the MDCs – not only in terms of mortality levels but also in terms of the cause of death {World Bank Report}

Non-communicable diseases are most important in MDCs, and are becoming more important in many LDCs (cf. Global Burden of Disease by Murray and Lopez)

But the burden of communicable diseases still predominant.

[Page 6 Table 1 from Cutler et al] makes this point forcibly comparing mortality levels and cause specific mortality between rich and poor (read developed and developing)

[Page 5, Table 5.3] Have some of the same information reported on page 5 of the handout. This time by the mode of transmission. Again we see the importance of infectious diseases.

This is the “unfinished agenda” in international health.

This predominance of communicable diseases is especially true for children.

Page 8 of handout [table causes of death < 5] WHO (neonatal causes: first month)

2. Determinants of Mortality in LDCs

What are the causes of changes in mortality in LDCs?

Is it the same reasons as in MDCs (mix of improvements in standards of living and public health measures)?

Most studies argue that the role of improvements in standard of living is less important in LDC than in MDCs (in the past). Greater role for public health and medicine.

Evidence:

   Preston study of the relationship between income per capita and e0. A classic in demography.

[Preston graph and table]

He looked at the relationship between income and e0 at different points in time.
If you look at the relationship for one year you see there is a strong relationship between the two, especially at low levels of income.

The poorer countries have lower levels of life expectancy. Income plays a role: individual ability to purchase food and other daily necessities (clothes, shelter).

(ask someone about Caldwell’s poor and superior health achievers)

Income doesn’t explain all the variation (cf. Caldwell’s poor health achievers and superior health achievers), but still explains a good deal.

But the point here is different: have a dynamic perspective – look at change

But if you compare the relationship at two dates: the relationship has changed over time.

At a given level of income you are better off in terms of survival with the conditions in 1960 than in 1930. This means that the change in income doesn’t account for all improvements in mortality.

Total change in $e_0$ 1930 to 1960 = 12.2 years.
  1.9 years due to change in income levels (16%)
  10.3 years due to change in other factors (84%)

This is what Preston calls “Structural Shift” (as does everyone else)

Includes improvements in:
  • Sanitation
  • Hygiene
  • Knowledge
  • Medical technology
  • Immunization campaigns
  • Foreign assistance

This study is important in the sense that it showed that like in MDCs improvements in income are not entirely responsible for mortality decline. Even if per capital income doesn’t change, mortality would decline because of this “structural shift”.

(From Preston article) This graph and results use all countries (both LDCs and MDCs) Control for literacy and food consumptions and look only at LDCs (like in the article you had to read) you would find that about 50% of the $e_0$ gains between 1940 and 1970 are due to structural shift (exogenous factors to national levels of income, literacy, and food consumption).

(More precise than earlier graph)
There are many other studies which focus on the role of factors other than income in the mortality decline.

Policy implications for LDCs: there is much that can be done for health improvements besides economic development.

Gives credence to public health interventions.

{World Bank} also says a lot about the role of the public sector
{Caldwell} talks about the importance of health services in LDCs

It is estimated that the role of public health and medicine is larger than in MDCs in the past. The knowledge and technology to fight against diseases was non-existent in the MDC at the beginning of their transition. After WWII, at the time when most LDCs start their transition – such knowledge exists

Another widely-cited example of the role of public health campaigns in LDCs is the case of Sri Lanka. Cited by {Preston, Caldwell, Sen} It may an example of the fastest mortality decline ever recorded.

In the 1930s at a time when mortality was improving rapidly in Europe and in North America, $e_0$ in Sri Lanka (called Ceylon at the time) was about 35 years, every close to the levels recorded by England and France during the 17th Century.

Over a period of 20 years, $e_0$ increased rapidly to levels around 58 years (23 years!)

What happened?
Most of the gains are attributed to a large-scale malaria eradication campaign. Program started in late 1946.

<table>
<thead>
<tr>
<th>Year</th>
<th>CDR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1946</td>
<td>20.2/1000</td>
</tr>
<tr>
<td>1947</td>
<td>14.3/1000</td>
</tr>
<tr>
<td>1930-45</td>
<td>21.8/1000</td>
</tr>
<tr>
<td>1946-60</td>
<td>11.7/1000</td>
</tr>
</tbody>
</table>

Malaria was endemic to Sri Lanka until the British began a coordinated campaign to eradicate the main vector, the *anopheles* mosquito.

The campaign was primarily aimed at spraying DDT (Dicholoro Diphenyl Tricholoro-ethane), type of insecticide. DDT sprayed in local households and attained an astonishing success. The claim is that the reduction of malaria accounts for the bulk of mortality decline, independent of standard of living.

Also: the effect particularly impressive because of a synergetic effect between malaria and nutritional status. At a given level of nutrition, people not affected anymore by malaria were able to better metabolize food, which had effects on their immune system. They become more resistant to other infectious diseases as well.
Sri Lanka is not a representative case but only one success story from which we can learn. Shows the impact of coordinated health campaigns and the role of the public sector – only the public sector is able to take the kind of wide-scale public health measures like in Sri Lanka.

{Caldwell} also discusses the importance of public sector in his article. He argues that mortality is more likely to decline in democratic societies where there is a fair amount of political activism.

This creates a climate where authorities feel responsible (held accountable?) for the health of the population and start the kind of health campaigns with potentially important positive health effects.

{Caldwell} says that “political activism and radicalism are the key elements in making health systems work”

(later?) {Sen} makes the observation that no famine ever occurred in democratic regimes. He argues that the key variable is not food production, but the redistribution of food, which is mediated by authorities. In the various famines that he studies, he said that food was available at the national level, but simply not equally distributed among the different population subgroups. He argues that democracy is the best way to promote better health in a country.

{Sen} also argues that mortality levels are a better index of development than are economic measures.

RECAP:
Mortality declines faster in LDCs than in MDCs in the past because of the availability of medical technology and a better knowledge of the positive effects of public health campaigns.

{Preston} Scheme for comparing LDC and MDC:

[table 5.8, p. 199 Fatal Years] - compare column c and column b

This is why at similar levels of income, mortality is better in LDCs today than in MDC in the past.


The socio-economic differentials in LDCs are also different from the ones observed in the US in the past.

{Preston – Fatal Years table 5.9 p. 201}
Today in LDCs the mortality advantage of being literate is greater than in the US in the past.

Also, there is an urban advantage today in LDCs (people richer in the cities and greater availability of health care). It was the other way around in the US in the past. The presence of technology today in LDCs exacerbates socio-economic differentials. Also, the availability/proximity of health care systems makes a difference today in LDCs. Didn’t make such a different in the US in the past.

**Role of MDCs in LDCs Gain**

Some argues that one reason for the much faster mortality declines in the LDCs today is due to the fact that LDCs receive aid from MDCs

{Preston} looked at this issue as well. He argues that money flows from MDCs to LDCs for health campaigns is not very large. Most health campaigns today in LDCs are financed at the local level.

The contribution of the MDCs is more technological than financial.

- Medical discoveries
- Training/diffusion of knowledge
- Development of low-cost health campaigns.

**Socio-economic differentials in mortality in LDCs**

So far we have looked only at mortality differentials across countries, using data at the national level.

What about differentials in mortality within different strata of the population of a country?

This can help to understand the factors associated with high mortality. Socio-economic differentials have policy implications – can also help to formulate policy for reducing mortality (we will look at policy implications later)

Socio-economic differentials: focus on role of income and education on mortality levels. The most blatant socio-economic differential is the fact that throughout the world, both in LDCs and MDCs, the poorer the strata of the population have higher mortality.

The {World Bank} argues that there is an important correlation between health and poverty?

Why correlation?

Draw graph also talk about inequality and its impact on mortality

Income allows you to buy: food, housing, medical care

Impact on mortality [draw graph]
Occupation → Income → (food, housing, med care) → mortality

{Sen} argues that income is a poor predictor of health after you control for other things, especially education. The {Word Bank} reports recognize that as well.

Education, and especially, maternal education, plays an important role. If you control only for income, you are going to over-estimate the direct effect of income.

[draw graph of pathways] Maternal Ed → socio-ec status, income → child mortality
Maternal Ed → child mortality (direct and indirect effect)

[chart by education]

Maternal Education more important than father’s education. Why? Answer: Women are most often responsible for child care. More conscious about health of children than fathers. Income more linked to father’s education.

[WB figure 2.4, p. 43]

The effect of education remains important even after controlling for income. Two women with the same level of household income have different levels of child survival depending on their level of education. Why?

{Caldwell} explains the possible pathways. Direct effect of education.

- Women’s beliefs/attitudes toward diseases, less fatalistic approach, belief that something can be done
- Better knowledge of modern health care. More where to go and what to do to receive care. Better communication with medical staff (dr., nurses)
- Better nutrition practices for children.
- Practice better hygiene.
- When women are more educated they are more likely to have more decision power within the household. Women are usually responsible for the care of children – they are the ones that need to negotiate allocation of resources for health of children. They will be more likely to be successful in this if they are more educated.

Also, important effect of education on adult education.

[WB Figure 2.5, p44]

Better knowledge of healthy health care habits, regardless of income. Have better adult health.

{Caldwell} talks also about the importance of female autonomy and the position of women.

More schooling. In societies with higher levels of female autonomy, women are more likely to go to school – positive health benefits.
More decision power, regardless of schooling. Women will have more decision power about allocation of resources in societies with higher female status (whether educated or not)

More female health workers in societies with higher levels of female autonomy

Women’s health status has an impact on gender specific mortality. Cf. The issue of excess mortality, high sex ratios, missing females in Asia. {World Bank} discusses women’s status and health.

{Sen} especially in India and Pakistan – there is excess female mortality at young ages (in other countries, males have higher mortality)

Linked to low women’s status – notion that a female child is an economic burden (high dowries, few economic benefits for parents after marriage of daughters), whereas male child is an economic asset (economic support for elderly)

As a result, there are differences in parental health practices toward male or female children. Regarding: food allocation, visits to doctors, etc. In societies with greater female autonomy there is more equality in the resources allocated for the care of male and female children. The health investments for female children are greater, and this contributes to lower mortality levels at a national level.

Policy Issues

1990: World Bank: World Summit for Children
1993: {World Development Report} – Focus on Health

Took advantage of research results to develop policies that covers more than health.

Table 3
1. Economic Growth and Female Empowerment
   • Focus on poverty reduction through economic growth
   • Education, particularly for females
   • Female Status, women empowerment

2. Public Health: information campaign highly cost effective
   • School based services
   • Information for family planning
   • Programs to reduce alcohol and tobacco consumption

Regarding health care systems: focus on the role of governments (public sector) – understand that private systems help the rich more than the poor

Focus on cost-effectiveness: as measured by the burden of disease reduced per dollar spent.

Importance of what they call “essential clinic services” – definition varies according to local socio-economic and cultural conditions, but includes at least:
   • Pregnancy related care
   • Family Planning services
   • TB control
   • Control of STD
• Care for common serious illnesses of young children – diarrheal diseases, acute respiratory infection, measles, malaria, and acute malnutrition

3. Also encouraged development of private sector as well (private insurance, private clinics) – healthy competition for services: improves quality and reduces costs

Also, debate about targeting: provision of free services for poorer individuals most at risk, while richer people should pay.

Positive aspect of targeting: helps those who are most at risk, decreases inequality (economic efficient – apply resources where most needed)

Negative aspect of targeting: administrative cost associated with targeting, erosion of political support from high-middle classes. May induce social stigma.

WB states that targeting inevitable in low-income countries.

An important contribution of the WDR is the inclusion of a new measure of health that includes disability:

\[ \text{DALY} = \text{disability adjusted life years} \]

How to understand DALYs: the more DALYs the worse the health (like deaths, measures burden)

Includes years of life lost because of of death or disability

Main criticisms of DALY
• How to measure the severity of the disability?

• Application of age weights – years of life lost at younger and older ages do not contribute the same as years of life lost during an adult age (related to economic value of individuals at various ages). Pre-eminence of the economic benefits of good health over simple general well-being of the population.

Nonetheless, DALYs are frequently used in international health publications.

Main Result of using DALYs rather than mortality
No big difference when comparing burden of disease across regions (higher mortality, the higher the total burden of disease (death+disability)

[Fig 2 WB]

When comparing causes of death, using DALYs put much more emphasis on non-communicable diseases (because most degenerative diseases do not lead immediately to death, but have long periods of disability, and because age weights put less emphasis on childhood ages where communicable diseases are more prevalent)

The widely discussed conclusion that non-communicable diseases are now becoming a major problem in LDC was in part due to the use of DALYs than mortality.

Emerging Health Threats {Levins, WB, Horiuchi}
New Infectious Diseases {Levins}
Contradicts the classical epidemiological transition framework.

While burden of communicable diseases decreased substantially everywhere, some new infectious diseases have emerged and some old infectious diseases have re-emerged.

What is a new disease?

[Fig 2 – Levins]

Black lung – respiratory disorder for coal miners due to inhalation of coal dust

In the article by {Levins} there is an exhaustive definition of “new diseases. This also includes the re-emergence of old diseases.

“New Diseases” may have existed for awhile but were not widespread enough to be known. For example, AIDS diagnosed in 1981.

Reason for new diseases:
  - Infectious diseases develop drug resistance
  - Vectors become insecticide-resistant
  - Because of adaptation – micro-organisms and vectors go through process of natural selection
  - Increased communication (reduced travel times allow local diseases to spread)
  - Changing environment/ecosystem.

For example, human activities affecting biological diversity increases the spread of infectious diseases (less competition between vectors and other species)

Man-made habitats for mosquitos – irrigation, construction sites, polluted water pounds

Climate change – (change in global temperature) potentially linked to industrialization has impact on the development of diseases

Development of alga blooms in coastal areas: linked to sewage and fertilizers pouring into ocean, overfishing – these algal blooms are breeding sites for cholera.

Importance of environment change

**One New Infectious Disease: AIDS**

Brief presentation (well discussed in media)

Among list of new infectious diseases

Differences of AIDS versus other new diseases
  - Longer incubation period: symptoms appear only after 2-14 years (greater potential for spread, many people don’t know they have the disease
  - No acquired immunity – unlike many other infectious diseases. Once you get it, you don’t develop immunity for it.
  - Sexual behavior is one of the major modes of transmission – more difficult to study because sexual behavior is everywhere considered a private matter rather than something you can openly discuss.
Look at Table showing the geographical distribution of persons living with AIDS
[table 4.1]

Overwhelmingly in Sub-Saharan Africa
Also, South and South East Asia

What can Demography contribute to an Understanding of AIDS?

- On $e_0$ effect is very large. Drops in Southern Africa have been as much as 10-15 years, wiped out gain of several decades.

[chart drops in $e_0$]

- On population growth – no large impact as fertility high enough to keep population above replacement

Other contributions of demography/sociology:

Study of sexual networks

The structure of sexual networks has a great impact on the spread of AIDS. It is not only the number of partners that matter, but the types of partners (prostitutes, spouses, girl-boyfriends). If individuals have sexual partners that are contained to one type, the infection gets fairly rapidly saturated. The infection stays in one high-risk group.

The disease spreads very rapidly to the larger population if individuals have partners of different type.

This is one reason why HIV/AIDS spread very rapidly in Sub-Saharan Africa, because sexual networks included different types of partners.

Pre-marital and extra-marital sex fairly common in Sub-Saharan Africa – seems to be encouraged in part by the practice of long periods of post-partum abstinence (no sexual intercourse after birth) for women.

Age difference between partners matters

And migration also important for the spread of AIDS

Demographers also study the impact of AIDS on family structure. Rise in the burden of dependency at the household level (number of children and elderly per adult individuals increased considerably because of AIDS affects mostly young adults. Only children and grandparents remain.
Mortality in More Developed Countries (MDC)

(distribute handout #3 on mortality)

Main themes:
- Morality levels in MDC today
- Future prospects and trends: debate about the limits to human life span
- Examples of mortality increases – what do they mean for the future of mortality?

Mortality differentials what are the sources?
- Sex
- Genes
- Personal Behaviors
- Marital Status, social support
- Socio-economic

Mortality patterns in MDC’s Today

Trends

[show chart of $e_0$ in some MDCs] (update)
Recent phases in the mortality transition (since the 1960s)

You can see that there were steady increases in $e_0$ throughout the period.

$e_0$ is already high in the 1960s ($e_0$ around 70 years).

Many people thought that further gains would be difficult. Infectious diseases were already very low, and there was a view that not much could be done against non-communicable diseases. People thought that non-communicable causes were unavoidable (associated with modern life).

Note Japan: very rapid mortality decline; had the lowest $e_0$ in 1960 and today has the highest.

Note slowdown in $e_0$ recently, for example in the U.S. U.S. $e_0$ did not increase as fast as in the other developed countries (because of high mortality among sub-groups which did not improve their mortality as quickly.) $e_0$ for whites only in the range of what is observed in Western Europe.

[chart Wilmoth]

The slowdown in the U.S. is obvious in this chart that shows long-term trends (since 1900). However, there is no evidence of slowdown the decline of mortality rates. How is this possible?
This is because recent mortality declines in MDC occur mostly at *older ages*. Mortality at younger ages is already very low. Almost no room for further declines.

Most of the mortality improvements in MDCs today occur among older ages.

Mortality decline at older ages has less impact on $e_0$ than mortality decline at younger ages. Why? (If you avoid a death below age 5, mostly likely the individual will survive to age 70 or 80. Thus gain 65 or 75 year incremental effect. If you avoid a death from someone at age 70, the incremental gain is only a few years [10 to 15].)

As a result, mortality decline at older ages have less impact on $e_0$ than mortality decline at younger ages.

This is why there is a slowdown in some MDCs today, even though age-specific mortality have continued to decline. Sometimes mortality decline at older ages has accelerated.

Question: What is the situation today?

**Levels**

What is the range of mortality levels today in MDCs? Let’s have a look at the highest $e_0$ in the world:

[Show chart highest levels of $e_0$ in the world]

This hear is for both sexes combined, average around 80 years. $e_0$ for females is higher; $e_0$, Japan females = 86 (2007)

What do they imply for survival to various ages?

For example, $e_0$ in the U.S. in 2004 = 77.9 years (men and women)

This implies

$$\Pr(T \geq 70) \approx .76$$
$$\Pr(T \geq 80) \approx .54$$

More than half the people can expect to live to age 80, according to mortality conditions of the year 2004. In fact, the probably of a newborn in 2004 will be even higher, because most likely there will be future declines in mortality.

So mortality in 2004 is a conservative estimate of the mortality conditions in which a baby born in 2004 will be exposed.

**Cause of death**

{Horiuchi}

[char National Vital Statistics]
Dominated by non-communicable diseases
Cardio-vascular (diseases of the heart) is the most important cause of death today.
Second is cancer (neoplasms)

These two causes account for more than half (∼ 51%) of deaths today.

An important fact, however, is that cardio-vascular diseases started to decline in several MDC {Horiuchi}. 31% in 1998, 29% in 2001

Important factors of decline
- Drugs against hypertension
- Low-calorie and low-fat diet (vegetable and fruits)
- Exercise

Consequently, cancer is on its way of becoming the leading cause of death relative to other causes.

In the U.S. it is still second, but in some other industrial countries (France?) cancer is already the leading of death.

Important fact of the 1990s: cancer mortality started to decline. Declines observed in Canada, U.S. and European Union. Not sure if the decline is transitory or long-term – but gives hopes for further reductions in mortality.

Explanations for Recent Mortality Decline (last 30 years)
- Role of medicine: important for recent declines (drugs and surgery) in cardio-vascular decline.
- Importance of public health (finding and communicating information on risk factors/health behavior [diet, smoking, alcohol, exercise]).
- Anti-smoking campaign: had major effect to increase e₀ in MDCs.

Prospects for the Future

How long will the mortality decline continue?
What are the prospects for the future?
Are we approaching a limit?

Article by {Wilmoth} makes the distinction between the pessimists (who believe there is no way mortality can keep declining) and optimists (who believe that like in the past, technological progress/discoveries will cause mortality to continue to decline)

Who would have guessed in 1900 the large improvements in e₀ to occur during the 20th Century? May be in the same situation today. (JRW: Yet, large increase due to eliminating infectious diseases. More appropriate to consider gains in last 20 to 30 years.)
One interesting fact is that projections of gains in $e_0$ by official statistical agencies (e.g., U.S. Social Security Administration) are generally conservative (too low). Life expectancy increased more than forecast.

[chart from B6B]

What does this tell us?

Answer:

• Better to project on the basis of mortality rates than $e_0$. (Wilmoth) Because declines in mortality rates have been more steady than decline in $e_0$ (technicality I explained earlier).
  
• Not a good idea at this point to impose a limit on $e_0$, because there are no theory or empirical evidence at this point which allow us to calculate this limit.

Cf. Earlier calculations of limits to $e_0$

In 1978 a French demographer (Bourgeois-Pichat) calculated that the biological limit to $e_0$ was 73.8 years for men and 80.3 years for women. Life expectancy in Japan exceeded these values in 1982 for men and 1985 for women.

Why was the estimate bad? He calculated what would be the life expectancy at birth in the absence of what he thought were “avoidable causes” or “exogenous causes” i.e., communicable diseases and injuries. He thought that “endogenous causes” (non-communicable diseases) were part of the aging processes and itself could not decrease. He didn’t predict decreases in non-communicable diseases as well.

Is there a limit at all?

Everyone agrees there must be a limit (just don’t agree to the limit).

• Intractable biological limits
  
Even the most sophisticated new developments in medical technology will not make people immortal

• Practical limits

Cost-effectiveness: Even if technology exists, it is likely to be very expensive. It may not be financially feasible to reduce mortality if all further mortality decline depends on high-tech procedures. There may be higher priorities at the societal level than allocating very large financial resources to mortality reductions.

• Empirical Limits
Highest age at death ever recorded is 122 years (female, Jean Calment 1875-1997) 115 years (male, 1982-1998). Distinction between life span at the societal level (e₀) and maximum life span.

The debate is not whether there is a limit, but whether we are approaching the limit.

- What do pessimists think about limits to e₀?

They think that we are not far from the limit, that further gains will be slow. Claim that e₀ can not go beyond 85 years (Japan today for females above that and still increasing).

The conclusion is based is ideas from evolutionary biology. According to evolutionary biology, genes that are beneficial for survival to reproductive ages are transmitted to the next generation. Genes that affect negatively survival to reproductive ages are not transmitted to next generations. There are eliminated through the process of natural selection.

Genes that are bad for survival but that operate only past age 50 are not exposed to the force of natural selection. They are transmitted to the next generation.

On this basis, it is theorized that natural selection does not help people to survive much beyond reproductive ages. According to these views, physiological degradation and mortality associated with senescence (aging) is unavoidable.

Problems with this approach:

- Some genes that are good survival at younger ages may be good at older ages as well (also “good-parent” effect children with good parent more likely to survive, genes may be transmitted)
- Human survival not determined solely by nature. Human intervention can affect survival past reproductive age.

- What do Optimists think about limits to e₀?

1. Looked at recent acceleration of mortality declines.

2. Note the unusual longevity of certain population groups
Researchers have studied mortality patterns of some religious groups (Mormons, Adventists) that are believed to have very healthy life styles and are protected from many risk behaviors. Have life expectancies around 90 years.

3. Application of existing technologies could extend survival further, such as further improvements in health behaviors (smoking, alcohol, diet, exercise): can have a great impact on survival. Although have experienced improvements have been recorded recently, much more can be done (smoking still high in some MDCs for example) this gives prospect for future declines.
4. Look at maximum age at death ever recorded or trend in maximum age at death recorded each year in Sweden.

[show chart]

This maximum age at death has been increasing – no evidence for limits to human life span.

What does this tell us about society at large? – It shows there is still room for improvements.

But what do these exceptional groups tell us about society at large? It is difficult to imagine a society where everyone will live the protected lives of the certain religious groups.

5. Other source of optimism: are we on the verge of technological breakthrough?

(a) New cure for cancers around the corner? Problems associated with cancer mortality seems more difficult than with cardiovascular mortality. Heart disease found in humans, but not in animals, which supports the idea that heart disease is avoidable.

However, cancers are found both in humans and animals, which suggests cancers processes are more biologically fundamental and thus more difficult to control.

(b) Gene therapy – manipulate genes associated with aging process
Laboratory research shows that gene manipulation can improve the longevity of certain species (fruitflies, worms, etc.) There seems to be some mechanisms that, if activated, can improve longevity. It is very early to say it there will be some applications for humans.

So, what is the best strategy now for predicting the future of mortality?

{Wilmoth} Extrapolation techniques
Use the past trend to predict to future. (Approach favored by demographers)

2050: $e_0$ should be around 85 years in the US (both sexes combined) 2005 78 for males and 82 for females. Doesn’t mean that it is a biological limit to $e_0$ – but an estimate for the year 2050.

Japan 2050: 87.1 years (83.3 men, 90.9 women)

Not reasonable to project past 2050.

Problems with this approach: It is mechanical and doesn’t help us understand the processes associated with longer longevity and the process of aging itself. But straightforward and understood by all.
Key point: Biological limits to longevity exist — but no sign that we are getting close to it at the moment.

An important question: Are we living longer but doing worse? (adding years of life in bad health)?

Notion of healthy life expectancy. Healthy life expectancy trends suggest that, no, we are living longer, but also healthier.

Increase in $e_0$ was mainly due to increase in years of life without disability.

But in the long term? Not sure that this will always be the case. Need to think also about quality of life and about costs associated with social dependency.

**Examples of Mortality Reversals** (quickly)

Mortality decline in MDCs should not be taken for granted

Last time, mentioned AIDS and new infectious disease: examples of increased mortality from particular causes.

However, for infectious diseases the populations most at risk seemed to be located in developing countries (look, for example, at the case of AIDS – AIDS mortality has decreased substantially in MDCS recently).

What about mortality increases in MDC?

Mortality decline is not universal.

Example: violence is in the U.S.

{letters to Wilmoth} say the mortality from certain causes can increase

[chart Wilmoth]

It has been increasing. Look at trend in fire-arm injuries and homicide (first cause of death among 15-24 year olds).

Much more difficult to control than things related to risk factors such as diet and exercise. Related to many other social problems. Related to what {Horiuchi} calls “Social Alienation”

World Health Organization: Say that violence should be considered a public health problem. Says that research is needed for violence reduction.

Some directions
  Availability of weapons
Programs to prevent suicide
Anti-violence campaigns

Another example: Mortality crisis in Russia/former Soviet Union (SKIP)

[chart e₀ in Russia]

Note: mortality was already declining before the break-up.

Crisis related to increases in mortality from three major causes:
- Smoking
- Alcohol
- Violence/accidents

Mortality levels similar to those observed in the U.S. in 1950, but then lack of improvement in Russia, while improvements in the U.S.

Why the sudden increase in e₀ after 1985?
- Anti-alcohol campaign by Gorbachev.
  - Analysis of detailed data revealed decrease in mortality related to decrease in poisoning and injuries.

  Campaign:
  - Reduction in state production of alcohol
  - Increases in price (of alcohol)
  - Decrease in number of stores (reduce availability)

  The measures were very unpopular; Gorbachev lost a great deal of popularity because of the campaign. People thought it counterproductive because of increased production of “home brew”. But in reality there were real benefits for public health.

  The decrease after 1991: effect accentuated by the previous increase after 1985.

Causes explaining the decreases are the same as the causes explaining the increase in e₀ in 1985 (alcohol related).

Free market, impossible to control supply of alcohol; production increased.

(skipped)
It is important to note that after 1991, there are no large increase in infant mortality and in mortality from infectious diseases.

This supports the hypothesis that the causes of the health crisis in Russia is not due to mass impoverishment and malnutrition (would show up in infectious diseases among most vulnerable groups).

Also after 1994, e₀ got better, although GNP continued to decline.
No so much deterioration of health care system or ecological factors. Would show up in specific cause of deaths as well, such as infectious diseases. Infant mortality would have gone up.

Alcohol is the main cause, but also other reasons for health crisis linked to abrupt change in social conditions mass psychological stress (inability to adapt, state of confusion, loss of self-identity)

Changed from world power, with feelings of pride to a poor country with limited international influence.

After 1995 adaptation to new realities:
   But e₀ still very low in Russia and the former Soviet Union.
   Recovery still limited:
   2002: 67.5 (both sexes)  62.29 (men)  72.97 (women)
   2005: 66 59 72
   2007 65 59 72
   (at 59 years e₀ in Russia lower than in Senegal)

The case for Russia shows that it is difficult to predict the future of mortality. However, Russia is not a complete reversal: this was not a return to pre-transition levels with infectious diseases.

**Mortality Differentials in MDC (reorganize)**

Low mortality in MDCs today at the national level but there are large differences within countries. And large and persistent health differentials within subgroups with each country. (Variation within and across countries)

What are the factors account for variation in e₀ in MDCs?

This is important for policy purposes – reducing inequality. Improvements in e₀ should not be the only goal – want to reduce health inequalities as well

Also – looking at mortality differentials within a country can help in understanding mortality differentials across countries. (e.g., mortality higher in U.S. than Europe because of large race differentials in the U.S.) But is this “an explanation?” (JRW)

In LDCs, when we looked at differentials we focused mostly on child mortality (cf. Link on maternal education and child mortality) {Caldwell/World Bank}

Now for MDCs we will focus on adult mortality because infant mortality is already low. Today will focus on differentials in adult mortality in MDCs.

We will examine the effect of
• Genes
• Conditions in Early Life
• Personal Behaviors (smoking diet, exercise)
• Marital Status, social support
• Socio-economic differentials
• Sex (M/F)
• And some interactions of these factors and others

Important to distinguish between the measurement of differentials (descriptive difference between population subgroups) and pathways (determinants). Much harder to distinguish cause and effect.

For example, as we will see there is an income gradient in health and socioeconomic status. Description is the measurement of gradient – difference in health status (mortality) by income group. Much harder to sort out causality – health affect income and income affect health. Dependence flows both ways. Advanced classes to sort out mechanisms.

Careful description is important and the start of the analysis. But the ultimate goal for policy purposes is to identify and estimate determinants.

Association → differential
Causal relation → determinant

Remember this difference between mortality differential and mortality determinant. It’s relatively easy to document a differential – just need a cross table of the mortality and the variable. Much more difficult to find a causal relationship.

Sometimes it is important to document differentials even if there is no direct causal pathway.

For example, it is sometimes argued that mortality differentials by race disappear if you control for other things (e.g., income and education). That is, if you compare blacks and whites with the same level of income and education. {Preston and Taubman} Nonetheless, ethnic differences in mortality are traditional computed by the National Center for Health Statistics. It documents the levels of inequality, even if race, per se, is not necessarily a determinant. Race proxies for other determinants of bad health.

Biological purist view: only biomedical processes are a direct determinant of mortality.

Genes

{Miller article optional}

Can survival rates be explained by genes?
Common observation that some people die early although they seemed to lead healthy life styles, whereas others die old in spite of certain risky behaviors. Not everything is due to differences in behavior, health care, etc.

This is especially true at very old ages – 85 to 95 – ages at which social differences are less prominent (b/c of Medicare).

Research now underway to look for genetic differences. Are there some specific genes that make people die earlier than others? Idea of an aging-clock that is genetically programmed. Are there some genes that, if modified, can increase longevity?

The first evidence about the genetic influences on longevity is the existence of genetic disease – Alzheimer’s.

But more generally is there the presence of genes that accelerate or de-accelerate aging, regardless of genetic diseases – that is the notion of an underlying biological clock that controls the rate of depreciation.

Definition: **Aging**: the process that converts fit adults into frailer adults with a progressively increased risk of illness, injury and death. {Miller}

Aging is a process not a state.

The evidence is mostly from animal studies (in humans, social factors are so strong it is difficult to isolate genetic factors).

Study animals with a small number of genes, and look at survival of groups with different genotypes. It appears that some genes make animals live longer.

[chart for mice]

Difficult to understand the actual mechanism, and to isolate genes that retard the aging process for humans. Research on-going.

Nonetheless, it is commonly estimated that 25 percent of differences in longevity among humans are accounted for by genetic factors. Non-genetic factors account for 75 percent.

This means that even if one is able to isolate and manipulate genes that slow down aging, you will not diminish mortality differentials by such a great deal. (Do I agree with this claim?)

It seems more effective to deal with other factors.

**Conditions in Early Life**

{Elo and Preston in suggested readings}
Although we are looking at adult mortality, it is still important to consider early childhood conditions.

Whether an individual is going to live 80 years or 90 years may be affected by conditions in childhood, with potential long term impacts on health.

Barker (1991) claims that it is conditions in utero – before birth that have effects on adult health. Growth of the fetus makes it have more or less susceptibility to disease.

What is the evidence:
- Cohort effects are well demonstrated for Respiratory TB
- Diseases can be latent: you get the infection during childhood but develop the disease as an adult.

Another disease related to childhood conditions: Hepatitis B

Adult height is among other things an indicator of nutritional environment and the disease environment during childhood. There are genetic factors as well – but nutrition and early infection is the most important factor for height worldwide.

It turns out that height is linked to adult mortality – especially for cardiovascular diseases. (Not good news for me.) Shorter individuals more at risk because they have narrower coronary arteries.

One piece of evidence of cohort effects in mortality: People born during wartime (or people who are young during war time) seem to have higher mortality later on.

[chart Caselli]

Early-life Conditions: account for another 25 percent of variation of adult mortality.

Other 50 percent due to adult conditions.

**Personal Behaviors** (smoking, drinking, diet, exercise)

These are for adult mortality not for child mortality.

Let’s look at the evidence:

**Smoking**
(see NYT article on how difficult to study risk factors)

1964 US Surgeon General establishes smoking as a risk factor

Diseases associated with smoking
Direct: Lung cancer, other cancers, pulmonary diseases
Indirect: vascular diseases

[show chart from Lancet]

US study: Compares current smokers (most of them were life-long heavy smokers, average pack a day) versus never smoked. Result: Death rates of smokers on average twice that of non-smokers. 24 times greater for certain diseases, such as lung cancer. Even a few cigarettes increases the risk.

Cigarette smoking has been a major factor explaining why mortality among US males stopped declining in the 1960s then decreased substantially. Anti-smoking campaign one of the (few) great success of epidemiology

Alcohol
U-Shaped relationship
Moderate intake during meals – lower risk than no intake at all
Benefits particularly important for people with diabetes [top chart]

[chart alcohol abuse]

Higher intakes – higher risks

Effects can be both immediate (alcohol poisoning) and long-term. (Alcohol mortality particularly important in Russia.)

Diet
Fat intake, salt intake
Less solid evidence

US Surgeon General 1988: dangers of dietary fat. Supported by several links:
Hard, saturated fat $\rightarrow$ higher blood cholesterol levels
Higher blood cholesterol $\rightarrow$ clog arteries (atherosclerosis)

Atherosclerosis $\rightarrow$ higher risk of coronary disease and heart attack.

Each link is well demonstrated, but the chain as a whole is not well supported by the evidence. Longitudinal studies fail to prove that people eating less fat are at lower risks. Obesity and diabetes (not so much linked to fat intake) seem to be more important.

Results: Total fat consumption has no relation to heart disease. Some fat (e.g., olive oil) reduce risks. Saturated fat not worse than carbohydrates (pasta, potatoes) that used to be recommended by nutritionists. (not necessarily any more.

Millions of dollar spent in these studies have failed to prove that eating a low-fat diet will help you live longer.
Despite lack of evidence, the message about low-fat diet hasn’t changed big-business. Also it is like a dogma, people take it for granted. (Really?)

Same thing about salt intake – apparently no relationship between salt intake and blood pressure (hypertension).

**Exercise**

[chart varsity]

The evidence is somewhat stronger: people exercising are at lower risk of heart attack than people not exercising.

Problem: healthier people are more able to exercise.

Cf. Results of college alumni – whether you were an athlete in college or exercised in college or not doesn’t put you at lower risk if you don’t maintain sports activities.

[chart summary] Minimized all different risk factors

**Stress (allostatic load)**
- Hypertension
- Cardiovascular diseases

{Adler}

Stressful life events:
- Unemployment, illness/death of family member, divorce (more prevalent among lower ses)

Consequence: depression is more prevalent among lower SES groups.

Other stressors:
- Living in a violent neighborhood
- Job with low autonomy and high performance pressure (factory worker, cashier)
- Low quality of interpersonal relationship: more hostility among lower SES groups

Quality of interpersonal relations – chances of having impaired social relations with family members and colleagues are higher among lower SES

{Adler} it is the relative SES placement rather than the absolute SES placement that matters. Where you stand in a given society, rather than what you can afford at a given SES status. “Social Ordering”
Not very strong evidence, put summary of what you need to think about when you talk about risk factors. Difficult to measure.

Mortality differentials by risk factors: very close to medical research.

Medical research similar to “proximate determinants” find associations.

**Differences in Sex (M/F)**

Let’s start with Sex! Differentials.

{Vallin} Use dup of determinant to explain differentials (sex, socio-econ)

Sex is a differential and a determinant:

- **Determinant:** if there are biological differences between men and women which have an impact on their mortality.

- **Differential:** their behavior/social status is different – impacts on mortality. Sex is a proxy for other things.

Note that for policy purposes, if you want to reduce male and female mortality differentials, there is not much you can do about biological differences. On the other hand, you can have an impact on the social status of men and women or on behavioral variables.

[chart $e_0$ in Sweden] – pattern observed in MDCs

If you look at $e_0$ in Sweden by sex you see that in the past there was practically no difference between male and female mortality – small female advantage, but not much; nearly equal.

But then the differential gets larger – female mortality declined faster than male mortality, and as a result, larger differential between male and female $e_0$.

**Most important question here:** gene, early life, life style?

Is the mortality differential due to genetic differences between male and females. Why do females have an advantage? Why does the differential change?

**Genetic Differences**

{Vallin, Waldron}

Remember that individuals have one pair of chromosomes that is different depending on whether the individual is male (XY) and female (XX).

Does this different gene composition have an impact on mortality?
There is a consensus that males are biologically more vulnerable than females. (Weaker sex is the male variety.)

Why? In most societies, including historical populations where the status of females was lower than today, infant and child mortality is higher for males. At these ages (especially in the first week of life) the role of behaviors – diet and other risk factors – is not salient (for mortality). Differences at the early age can be attributed to biological factors. (For societies that exhibit no son-preference – not Asia.)

Can also compare cloister populations – monks/nuns that have nearly identical life styles (attempt to control for social, behavioral factors). Males still have higher mortality.

This biological difference has to do with sex hormones (testosterone for males and progesterone for females) that interact with certain diseases. Females have an innate advantage (except for some risks, e.g., childbirth).

Social Reasons explaining mortality differentials

Life Style of Males
- Historically more likely to smoke than women (this is changing)
- More likely to drink
- Drive more frequently
- LFPR higher among males – more likely to work in risks occupations

{Vallin} provides evidence by looking at specific cause of death linked to these factors.

Life Style of Females
- Historically: some degree of protection (women and children 1st)
- No military service (changing)
- Smoke and drink less (changing)
- Work less and work at jobs that carry less risk (lumberjacks)
- Different attitudes toward health and body – take better care of themselves than do men (important)

Why did differential increase over time?
- Some degree of discrimination against females in the past even in Industrial societies (diminished over time)
- Before advent of modern medical technology, women’s healthier attitudes had no margin on which to operate.
- Maternal mortality higher in the past
- Recently – increase smoking by Males

Prospects for the future: Male and Female Lifestyle are becoming more similar, more alike. This should lead to a reduction in mortality differentials. But because of genetic
differences, it is likely there will always be a certain degree of difference – favorable for females.

Note that although males die sooner than females, males are born in greater number than females. So that at reproductive ages the number of men and women is about equal.

Certain countries, South and East Asia, have son preference, much higher proportion of males (1.1) In these countries, female mortality is higher than that of males because of low female status (less adequate health care and diet).

Socio-Economic Differentials

Overlap with earlier discussion.

There are some other differentials for which the pathways are no so clear. These include socio-economic differentials in mortality.

When thinking about pathways, you have to make a distinction between socio-economic differentials explained by differences in risk factors, (better off people also tend to do better in all the risk factor categories) and differences that remain unexplained even after controlling for risk factors.

Income is an obvious another important factor.

Income – correlated with education, occupation, social status

Parent’s ses influences childhood exposure affects child’s income, education, occupation which affects risk factors and access and utilization of health care which influences morbidity and mortality.

I have talked about this a lot already, not much more to say. Social programs can be used to reduce differentials. Cf. Social security systems lower the disadvantages of the low income.

[look at chart]

Socio-economic differences through proximate determinants (directly) for behaviors? Important question: Why do poor people smoke more? Have higher alcohol consumption?

{Preston-Taubman} When future is not bright, daily struggle to meet basic needs, individuals have less incentive to preserve health. Higher priorities on instant (current) needs (food, clothing, shelter), lower priorities on distant dangers (future disease). Exercise, smoking
need to project yourself in the future. Defer instant gratification for future health. Also neighborhood effects (climate of nhb makes people more or less health conscious).

One Problem: it is not obvious which box [in chart] is the most important. For policy purposes, it would be important to find out. More effect to improve access to health care, or to focus more on prevention by reducing prevalence of risk behaviors?

Things not included in the box, although potentially important:

*soci-economic differentials explained in part by early childhood conditions (25 percent of variation in adult health)

Reverse causality.

One piece of evidence is the existence of a gradient in the relation between ses and health. People with medium ses although they have money/education to attain good health, they are more at risk than people from higher classes.

So there seem to be factors other than just education and income.

People from higher ses groups are less exposed to specific stressors.

Discuss Ethnic differences: rather similar to ses – combination of materialistic/nonmaterialistic; genes play a role for certain diseases; cultural factors

Other differentials:

Marital Status (Goldman article)
Social Support {House article}

Facts:
1. Married people have lower mortality than single/divorced people.
2. People that are better integrated in networks of family/friends have lower mortality.

[chart]

Possible Explanations:
- Spurious – reverse causality: people who are healthier are more likely to marry and build social networks

- Potential direct effect: presence of other individuals attenuates the effects of stressful life situations (“buffer” effects) reduced BP, heart rate

- Indirect effect: practical help, provision of information, fostering a sense of meaning or structure that promotes health: Better sleep, and food habits, less risk behaviors, better health care seeking behavior.
Note social relationship can have negative effects on health if related to conflict. Need to think about the quality of social relationships, not only quantity.

Conclusion:
- Understand mortality differentials is complex
- Easy to document differentials
- Hard to understand causal mechanisms