Overview

- P/D/U/E
- P/E system checks: Disease, morbidity, & mortality
  - Strategy of survival
  - Age structure, survival, and fertility in transition
  - Four variable model
- Disease diffusion
  - Global and national patterns
  - Migration
- Uneven development: processes and patterns

P/D/U/E interactions

Population
- processes (B,D,M)
- patterns

Development
- processes
- patterns

Urbanization
- processes
- patterns

Environment
- processes L,H,A,B
- patterns

Population processes – strategy of survival

- Positive feedback
Population processes – strategy of survival

- Negative feedback

- Generational perspective:
  - Success = survival to reproductive age
  - Failure = die before producing off-spring

- Survival in historical perspective
  - hunter-gatherers
  - role of innovations
  - stability
**Population History of Selected Capitals of Preindustrial Epoch**

<table>
<thead>
<tr>
<th>Location</th>
<th>Period</th>
<th>Population</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rome</td>
<td>A.D. 100</td>
<td>650,000</td>
<td>World's largest city</td>
</tr>
<tr>
<td></td>
<td>600-800</td>
<td>50,000</td>
<td>Barbarian invasions</td>
</tr>
<tr>
<td></td>
<td>900</td>
<td>40,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>33,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1377</td>
<td>17,000</td>
<td>Pope returned from exile</td>
</tr>
<tr>
<td></td>
<td>1400</td>
<td>32,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1500</td>
<td>33,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1600</td>
<td>109,000</td>
<td></td>
</tr>
<tr>
<td>Alexandria</td>
<td>730</td>
<td>215,000</td>
<td>Sixth largest in world</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>180,000</td>
<td>After several sieges</td>
</tr>
<tr>
<td></td>
<td>1365</td>
<td>40,000</td>
<td>Plundered by Cypriotes</td>
</tr>
<tr>
<td></td>
<td>1400</td>
<td>40,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1634</td>
<td>“Heaps of ruins”</td>
<td></td>
</tr>
<tr>
<td>Mexico City</td>
<td>1500</td>
<td>80,000</td>
<td>Spanish conquest begins</td>
</tr>
<tr>
<td></td>
<td>1524</td>
<td>30,000</td>
<td>After destruction by Spaniards</td>
</tr>
<tr>
<td></td>
<td>1600</td>
<td>75,000</td>
<td>Rebuilt</td>
</tr>
<tr>
<td>Bagdad</td>
<td>765</td>
<td>480,000</td>
<td>Caliphate established in A.D. 780</td>
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<tr>
<td></td>
<td>932</td>
<td>1,100,000</td>
<td>World’s largest city</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>125,000</td>
<td>Tenth largest in world</td>
</tr>
<tr>
<td></td>
<td>1238</td>
<td>90,000</td>
<td>Sacked by Mongols</td>
</tr>
<tr>
<td></td>
<td>1400</td>
<td>90,000</td>
<td>Timberlane attacks, city sacked in 1401</td>
</tr>
<tr>
<td></td>
<td>1638</td>
<td>30,000</td>
<td></td>
</tr>
</tbody>
</table>

**Population processes – space of growth**

- Survival ($e_0$) = expectation of life at birth
- Reproduction (TFR) = total fertility rate
- Space of growth
  - isogrowth curves show alternative survival strategies.

**Population processes – strategy of survival**

- Age-dependence rather than crude rates.
  * Age-specific fertility rates (see website)
  * Age-specific death rates $\rightarrow$ survivorship curves.
- Population pyramid
  * shows historical record
  * captures population momentum

**Demographic transition(s)**
Population processes – Four variable model

Demographic Accounting Equation

\[ P(t+n) = P(t) + B(t,t+n) - D(t,t+n) \text{ } \{ \text{natural change} \} \]

\[ + I(t,t+n) - E(t,t+n) \text{ } \{ \text{net migration} \} \]

Disease, morbidity, and mortality

- Theories, classifications, and relative morbidity/mortality
  - disease – ‘absence of ease’
  - theories:
    * Demonic theory of disease
    * Four Humors (blood, phlegm, yellow bile, black bile) - Hippocratic Doctrine
      - natural over supernatural causes
      - temperament: sanguine, phlegmatic, bilious, melancholic (black bile)
    * Germ theory of disease - emerges 1850s-1860s, Pasteur
    - International Disease Classification (‘several weighty volumes’)
  - Sedgwick’s Sanitary Science and the Public Health, (1890, 1936).

“The student of sanitary science must take up the physiologists’ point of view. He must look upon the living body as a mechanism; a mechanism of curious origin and history and of marvelous complexity; the most wonderful of all machines; one before which the wisest of men stands very much as does the savage before the chronometer, ignorant of its origin, ignorant of its ultimate construction, ignorant of its fate; but yet unlike the savage because without superstition and without fear; knowing that the body is nevertheless a mechanism, subject to natural laws, and with all its parts cooperating to one end – the life-keeping function of the whole. The living body is like a machine, also, in that it receives all its energy from without and is merely a transformer of energy; in that it is profoundly sensitive (as is a watch) to its environment – to heat, to cold, to mechanical injuries.

...The period of growth and the period of decline – infancy and old age – appear to be the periods when death is least successfully resisted. As has been finely said: ‘In this last respect the two extremes of life resemble one another. The freshly lighted taper and that which is burnt down to the socket are both easily extinguished by the slightest puff of wind.’

Disease, morbidity, and mortality

External causes: physical, chemical, microbiological
Internal causes: genetic, developmental, neoplasms

Disease, morbidity, and mortality

External causes:
(a) Physical injury (e.g. trauma)
(b) Chemical injury (e.g. poisons)
(c) Microbiological injury (e.g. viral diseases)

Internal causes:
(d) Genetic diseases (e.g. congenital anomalies)
(e) Developmental diseases (e.g. cardiac diseases)
(f) Neoplasms (e.g. cancers)

Diseases of the respiratory system 12.3 (12.3%)
Diseases of the circulatory system 11.3 (11.2%)
Infections and parasitic diseases 17.5 (17.3%)
Cancers 6.2 (6.2%)
Other and unknown causes 6.3 (6.2%)
Puerperal, neonatal, and maternal causes 4.2 (4.1%)
Disease, morbidity, and mortality

Developing World

- Infectious and parasitic diseases: 9%
- Other and unknown causes: 5%
- Perinatal and maternal causes: 9%
- Cancers: 43%
- Diseases of the circulatory system: 23%
- Diseases of the respiratory system: 21%
- Total: 40 million

Developed World

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- Total: 12 million

Source: 1

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Disease, morbidity, and mortality

\[ \text{Fatality/Incidence} \]

\[ \frac{\text{Fatality}}{\text{Incidence}} \]

- Risk
  - \( n \): possibility of loss or injury
  - \( vt \): to expose to hazard or danger.

- Risk is inherently spatial in nature.
  * choice, behavior
  * location specific

- 'at-risk principle' in demography. 'Exposure'

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Disease, morbidity, and mortality: Risk

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- 'at-risk principle' in demography. 'Exposure'
Common features of disease emergence: (pp. 634, Haggett)

* onset appears sudden and unprecedented
* isolated cases retrospectively discovered that predate outbreak
* unknown pathogens/toxins account for many new infections.

Why the common features?

* improved disease detection
* pathogens already existed but may have evolved virulence through genetic mutation.
* changes in environment and behavior provide opportunity for disease to flourish
* pathogen reaches non-immune population (virgin soil epidemic).


- Economic Development
  * epidemiological transition
  * urbanization/development
- Spatial contraction
  * collapsing space (time distance, cost distance)
  * increased movement/mobility
    - exposure in other regions
    - exposure in airplanes
    - genetic mixing of disease strains (+,-)
- Land use changes
- Global warming
Disease, morbidity, and mortality: Challenge

Geographer’s Challenge – (pp. 652).

1. Disease control is likely to rely less and less on spatial barriers
2. Rapid reporting and surveillance are likely to be increasingly critical in control.
3. Ever-widening lists of communicable diseases and the high cost of surveillance will make sampling essential.
4. Geographic models will increasingly supplement other epidemiological tools in global control.
5. Disease control and socio-economic development are likely to be more closely tied together.

Disease, morbidity, and mortality: Changing Context
Disease, morbidity, and mortality: Models and Diffusion

Spatial models of infectious disease

- Disease processes in time and space
  - point sources: disease clusters
  - contagious diffusion

- Disease clusters
  - cancer, environmental linkages

Spatial diffusion: spatial dynamics of disease.

- Expansion diffusion
  - contagious/direct contact
  - distance
  - hierarchical

- Relocation diffusion
Spatial models of infectious disease (cont.)

- Contagious diffusion
  - Review spatial diffusion
  - What are the key elements of the spatial process?
    - spatial rate of transfer
    - disease waves
    - sustainable population
  - Policy intervention
Spatial models of infectious disease (cont.)

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An unidentified minor league baseball game in 1918. (Courtesy of Stanley B. Burns, M.D., and The Burns Archive)

A man is named as a Seattle trolley conductor because he has a record. (Courtesy of The Seattle Times, Merlin, Seattle, WA.

Lung tissue samples, preserved in paraffin, from victims of the 1918 flu. These and more than 3 million other tissue samples are stored in the National Tissue Repository maintained by the Armed Forces Institute of Pathology. (Courtesy of Eric Hanaoka)