Lecture 21: Subsistence Transitions, Women’s Status and Biology

- Extension of life span
- Subsistence Transitions
  - Hunting & Gathering
  - Horticulture
  - Agriculture
- Industrialization
- Demographic Transition
- Population Growth
- Limiting fertility
- Why don’t we maximize fertility?

Why did populations remain relatively stable for so long? Why did this stability change?

Human culture and technology have had a profound effect on human fecundity and fertility!

How did hunter-gatherers control their fertility?
Hunter-Gatherers

- Women contribute a significant amount to food production and preparation

Hunter-Gatherers

- Women contribute a significant amount to food production and preparation
- Women have relatively high status

Hunter-Gatherers

- High mobility and energy output — fertility checked primarily by response to local ecology:
  - Lactation
  - Energetics
    - Nutrition
    - Workload
    - Energy balance
  - Disease load

Fertility in Foraging Populations

<table>
<thead>
<tr>
<th>Foraging Population</th>
<th>Female Energetics</th>
<th>Total Fertility Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>!Kung</td>
<td>Women contribute &lt;70% calories</td>
<td>4.7</td>
</tr>
<tr>
<td>Hadza</td>
<td>Wean children 1 year later than !Kung, less exposure to disease</td>
<td>6.15</td>
</tr>
<tr>
<td>Ache</td>
<td>Women contribute 13% of calories, less time spent foraging, better nutrition</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Neolithic Transition

- Advent of agriculture ~ 10,000 years ago
- Changes in nutrition
- Changes in women’s workloads and energetics

Why did people adopt agriculture?

- “Pushed” by population expansion
- “Pulled” by agricultural innovation leading to population expansion
- Combination
**Agriculture: Horticulture Technology**

- Extensive field cultivation and hoe technology
- Women’s labor probably increased morbidity

**Changes in the Skeleton**

- Extensive field cultivation and hoe technology
- Women’s labor probably increased morbidity
- Seasonal lulls in activity allowed periodic increase in fecundity

**Seasonal Changes in Fecundity**

- Extensive field cultivation and hoe technology
- Women’s labor probably increased morbidity
- Seasonal lulls in activity allowed periodic increase in fecundity
- Weaning foods
Weaning Vessels

Agriculture: Horticulture Technology

- Extensive field cultivation and hoe technology
- Women’s labor probably increased - increased morbidity
- Seasonal lulls in activity allowed periodic increase in fecundity
- Weaning foods
- Higher fertility=Slow rise in population in post-Neolithic

Agriculture: Plow Technology

- Advent of the PLOW removed women from the primary productive sphere
  - Land more valuable and thus controlled by men

Agriculturalists

- Advent of the PLOW removed women from the primary productive sphere
- Reduced exposure to ecological and physiological stresses
- Increased fecundity and population growth
- Decrease in female status when removed from food production
**Hunter Gatherer vs. Agriculture**

**Fertility Rates**

- Hunter-Gatherers: Limited by ecological controls on fecundity, high workload
- Horticulturalists: Increase in women’s labor, seasonal lulls in production, weaning foods, increased fecundity because of shorter IBI’s

**Distribution of Total Fertility**

**Subsistence & Fertility**

- Hunter-Gatherers: Limited by ecological controls on fecundity, high workload
- Horticulturalists: Increase in women’s labor, seasonal lulls in production, weaning foods
- Agriculture (plow): Removal of women from most production, lower exposure to ecological stressors, increased fecundity & fertility
**Industrialization**

- Increasing numbers of women removed from the sphere of production - Decreased female status
- Decreased female status
- More women limited to the domestic sphere — reproduction no longer production
- Decrease in breast feeding practices

**History of Population Growth**

<table>
<thead>
<tr>
<th>When?</th>
<th>Population</th>
<th>Doubling Time</th>
<th>What?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 y.a.</td>
<td>1/4 billion</td>
<td>350 yrs</td>
<td>Old World meets New World</td>
</tr>
<tr>
<td>1650</td>
<td>1/2 billion</td>
<td>200 yrs</td>
<td>Industrial Revolution</td>
</tr>
<tr>
<td>1850</td>
<td>1 billion</td>
<td>100 yrs</td>
<td></td>
</tr>
<tr>
<td>1950</td>
<td>2 billion</td>
<td>40 yrs</td>
<td>Drugs, penicillin, lower mortality</td>
</tr>
<tr>
<td>1990</td>
<td>4 billion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Population Growth

The Modern Demographic Transition

- Mortality rates drop off first
- Then Fertility rates drop off

Modernization/Demographic Transition

- Industrialization
- Urbanization
- Spread of Education
- Improved health and nutrition
- Control of epidemic diseases
- Increase of communication facilities
- Erosion of traditional customs
- Emergence of secular values and beliefs

What affects Fertility?

Changes in Marriage Practices

- Increase Fertility:
  - Widowhood will occur later — can have more children if husband lives longer
  - Lower rate of rate of divorce & separation
What affects Fertility?
Changes in Marriage Practices

- Decreased Fertility:
  - Older age at marriage
  - Greater proportion never married
  - Voluntary abstinence
  - Involuntary abstinence

What caused the baby boom?
Was there an increase in family size?

What affects Fertility?
Health and Wealth

What affects Fertility?
Changes in Marital Fertility
What affects Fertility?

Female Productivity and Status

- Female control of Productivity decreases fertility rates
- Increase in female status decreases fertility rates

What affects Fertility?

Access to Contraception

Fertility Control:

(1) Quality vs. Quantity

- More investment in fewer children when resources make a difference
- Fertility declines with increased material wealth
- Within a society those with more wealth tend to reduce fertility earlier and more dramatically. This reverses the traditional positive association of wealth with number of children.

Why don’t we maximize fertility?

Maximizing Fitness does not necessarily equal maximizing children produced!
Modeling Quality vs. Quantity

Kipsigis Women: # Children & Fitness

Kipsigis Men: # Children & Fitness

Surviving Grandoffspring

Surviving Grandoffspring

Reproductive Success:
Albuquerque men

Surving Offspring:
Surviving Offspring:

Surviving Offspring:

Surviving Offspring:

Surviving Offspring:

Surviving Offspring:

Fertility Control:
(2) Artifact of quest for increased resources

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• In past increased resources led to more children through having increased energetic reserves (females), increased mates (males), etc.

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• Evolved psychological mechanism to seek increased resources -- not to increase RS directly
Income and Education: Proxy for Reproductive Success?

- In the past, income and education associated with more children, but not anymore.
- However, humans still have evolved psychology to try and increase resources because in the past that led to increased reproductive success.

Kipsigis Men

- Men concerned with maximizing wealth per child married fewer wives than men concerned with maximizing number of children.
- Behavior optimized to accumulate wealth over lifetime to maximize resources divided amongst sons.

Fertility Control: (3) Lineage Extinction

- How do you measure evolutionary outcomes?
  - Reproductive success vs. Lineage Extinction

Fertility Control: (3) Lineage Extinction

- Natural selection has two outcomes:
  - Lineage extinction
  - Lineage persistence

- High risk strategies (more children with little investment in each) leads to greater variance and higher rates of lineage extinction
Natural selection has two outcomes:

- Lineage extinction
- Lineage persistence

High risk strategies (more children with little investment in each) leads to greater variance and higher rates of lineage extinction.

Demographic Transition = Humans pursue a variance minimizing strategy (with more secure wealth - fewer children with more investment in each).

Fertility Control:
(3) Lineage Extinction

Why do we have Menopause?

- The Grandmother Hypothesis
  ➢ Selection for menopause in favor of investing in grandchildren
- Timing of senescence
  ➢ Selection for menopause so that can nurse final offspring before death
- Follicular Depletion
  ➢ Non-adaptive result of oocytes having a 50 year maximum ‘shelf life’ in mammals

Selection for Longer Life Span

For Grandmother Hypothesis to work, grandmother’s help needs to result in more than two grandchildren being produced for every additional child she would have produced herself.

Is Evolution a …

Horse Race? or Musical Chairs?

What does it mean to say something is ‘selected’ for?

➢ Those that have the trait that is ‘selected for’ have greater reproductive success than those that do not have the trait. Thus the trait gets passed on in the population.
Selection for Life Span

- Grandmother’s Productivity (Hawkes et al.)
- The Patriarch Hypothesis (Marlowe, 1999)
- Male and Female Productivity (Kaplan et al.)

Selection for Life Span

- Reformulation of Grandmother Hypothesis (Hawkes et al.)
  - Grandmother’s productivity led to selection for increased lifespan.

Selection for Life Span

- Grandmother’s Productivity (Hawkes et al.)
- The Patriarch Hypothesis (Marlowe, 1999)

Patriarch Hypothesis

“Once males became capable of maintaining high status and reproductive access beyond their peak physical condition, selection favored the extension of maximum life span in males.”
Age Specific Fertility in Ache

Reproductive Senescence

Patriarch Hypothesis
- Shift to less strength-based male-male competition.

Strength and Age in Hadza

Archery and Age in Hadza
Patriarch Hypothesis

- Shift to less strength-based male-male competition.
- Males can be high status and obtain mates even though not in their ‘prime’ physically

Fertility and Father’s Age in Hadza

Patriarch Hypothesis

- This ability in human males to keep reproducing after their physical prime would have selected for longevity.
- Such selection would have been on autosomal genes -- thus passed on to females as well.

Patriarch Hypothesis: Problem?

- When did less strength-based skills evolve? Spear very recent.

Selection for Life Span

- Grandmother’s Productivity (Hawkes et al.)
- The Patriarch Hypothesis (Marlowe, 1999)
- Male and Female Productivity (Kaplan et al.)

Human Forager & Chimpanzee Production vs. Consumption
Age & Productivity on Ifaluk

Selection for Longer Life Span
- Individuals with living parents have higher reproductive success (e.g. Ifaluk)
  - Direct physical contributions
  - Holding kin groups together and maintaining larger cooperative networks
  - Reliving physiological/energetic constraints on mothers

How Important are Grandmothers vs. other Family Members?

Evolutionary anthropologists disagree about who women rely on to help them raise a family.

Work on the Ache shows that men matter a lot.

Work on the Hadza shows that grandmothers are important.
How Important are Grandmothers vs. other Family Members?

- Which family members most help women’s reproductive success?
- Do life history models suggest these same kin were important in our evolutionary past?
- Can current patterns of diversity tell us anything about how these systems change over time?

Effect of death of kin on mortality rates of children

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Non-reprod</th>
<th>Reprod</th>
<th>Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>1.0</td>
<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td>48</td>
<td>0.9</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>36</td>
<td>0.8</td>
<td>0.7</td>
<td>0.6</td>
</tr>
<tr>
<td>24</td>
<td>0.7</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>12</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>0</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Conclusion

- Even though the risk of child death is increased far more by their mother’s death than their grandmother’s death, mother deaths are rare, whereas grandmother deaths are common.
- At a population level, more child deaths were caused by loss of grandmothering than by loss of mothering.

Effect of maternal grandmothers on survival rates of children

- Demographic, anthropometric & genealogical information for c.10,000 people.
- Primarily subsistence agriculture society.
- Patrilineal & patrilocal, but all kin were nearby.
- Fairly high levels of polygyny.
- 42% of children died before age 5.

Data

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Effect of Parents and Grandparents on Weight of Children in Rural Gambia

- Mother: 8.7, 8.8, 8.9, 9.0, 9.1, 9.2, 9.3, 9.4
- Father: 8.7, 8.8, 8.9, 9.0, 9.1, 9.2, 9.3, 9.4
- MGM: 8.7, 8.8, 8.9, 9.0, 9.1, 9.2, 9.3, 9.4
- PGM: 8.7, 8.8, 8.9, 9.0, 9.1, 9.2, 9.3, 9.4
- MGF: 8.7, 8.8, 8.9, 9.0, 9.1, 9.2, 9.3, 9.4
- PGF: 8.7, 8.8, 8.9, 9.0, 9.1, 9.2, 9.3, 9.4

Effect of Parents and Grandparents on Weight of Children in Rural Gambia

- Mother: 9.4, 9.3, 9.2, 9.1, 9.0, 8.9, 8.8, 8.7
- Father: 9.4, 9.3, 9.2, 9.1, 9.0, 8.9, 8.8, 8.7
- MGM: 9.4, 9.3, 9.2, 9.1, 9.0, 8.9, 8.8, 8.7
- PGM: 9.4, 9.3, 9.2, 9.1, 9.0, 8.9, 8.8, 8.7
- MGF: 9.4, 9.3, 9.2, 9.1, 9.0, 8.9, 8.8, 8.7
- PGF: 9.4, 9.3, 9.2, 9.1, 9.0, 8.9, 8.8, 8.7
Effect of Elder Siblings on Weight of Children in Rural Gambia

- 0 Sibs
- 1-2 Sibs
- 3+ Sibs

Weight (kg)

Sisters | Brothers

Next Time...

Women’s Health Issues

- Breast Cancer
- Stress and depression
- Sex differences in depression
- Does stress influence fecundity?
- Does stress influence ovarian function?