Demographic and Epidemiologic Transitions

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The basic demographic equation: Population change = births – deaths + net migration (Newell 1988). Migration is an important determinant of local demographic changes, but it does not affect human population size at the species-level and on the global scale (Ellison et al. 2012).

The two major demographic transitions are characterized by drastic changes in mortality and fertility that coincide with the epidemiological transitions of human diseases ecology (Gage 2005; Harper and Armelagos 2010).

Neolithic Revolution

* Behavior: Members of genus Homo were foragers until agriculture emerged in at least eight regions across the world in the early Holocene (Larsen 2006). This shift from migratory hunter-gatherers to sedentary agriculturalists beginning around 10,000 years ago greatly affected human patterns of behavior, disease, mortality, and fertility.
* Disease: Epidemics were uncommon in nomadic hunter-gatherer groups because the small population size and low density were unlikely to sustain the person-to-person transmission of infectious pathogens (Cohen 1989, 2009). Susceptibility to infectious epidemics likely increased with the transition to agriculture.
  + Crow diseases could be sustained at endemic levels in denser populations.
  + Animal domestication brought humans in closer and more frequent contact with zoonotic pathogens.
  + Food storage could provide an opportunity for bacterial amplification. Sedentism resulted in the accumulation of human waste in close proximity to living spaces. When compounded with poor sanitation, this allowed for the transmission of enteric diseases.
  + The diet generally became less varied with reduced meat and predominantly grain consumption (Larsen 2006). Increased consumption of carbohydrates resulted in greater prevalence of dental caries and other oral pathologies.
* Fertility: increased with decreasing interbirth intervals (Bentley et al. 2001)
  + Agriculture provided additional sources of weaning foods, which enabled earlier weaning and presumably shortened the period of lactational amenorrhea.
  + A sedentary lifestyle provided more opportunities for copulation because males were not traveling long distances to hunt game.
  + Sedentism also reduced them mother’s energetic expenditure on carrying children, which would be substantial in a nomadic lifestyle (Kramer 1998).
* Mortality: likely increased, but see limitations on interpreting the evidence
  + Reduced female survivorship during reproductive years is consistent with maternal mortality as a result of increasing birth rates. (Bentley et al. 2001)
  + Increased susceptibility to infectious diseases.
  + Increase in population density among agriculturalists was accompanied by increasing social stratification and complexity and the advent of market economies (Bocquet-Appel 2011). The novel social, economic, and ecological challenges associated with the Neolithic Revolution likely contributed to an increase in psychosocial stress and competition for resources that may have escalated to violence (Larsen 2006).
* Issues of data quality, quantity, and interpretation
  + Demographic information from the Neolithic transition must be obtained from archaeological and paleoanthropological evidence, which is inherently difficult to interpret.
  + Archaeological and paleoanthropological evidence indicates a youthful population at the peak of the Neolithic demographic transition (Bocquet-Appel 2011).
    - This indicates an expansive pyramid population age structure, which is characteristic of both high birth rates and high death rates.
    - A growing population with more young people necessarily biases estimates of the mean age at death and life expectancy downward (Gage 2005).
  + Osteological Paradox (Wood 1992) – Agriculture is associated with a higher frequency of bone lesions. This may be evidence of an increase in disease risk, which is a marker of poor health. This could also imply increased survivorship through disease episodes, which reflects improving health conditions.
* Population: Birth rate clearly increased with the Neolithic transition (Bentley et al. 2001). The death rate is more difficult to determine, but many of the mechanisms that might have increased mortality were dependent on an increase in population density. The increase in birth rate, therefore, likely preceded the increase in death rate, resulting in an overall increase in population size.

Industrial Revolution

* Behavior: Advances in technology, science, and medicine resulted in improved nutrition, personal hygiene, and housing (Omran 1998; Harper and Armelagos 2010). High-income populations started leading increasingly sedentary lifestyles with low levels of physical activity (Popkin 2008).
* Mortality: Improvements in sanitation, nutrition, income, and medicine have led to a decline in mortality at all ages (Oeppen and Vaupel 2002).
  + As a result, life expectancy at birth has doubled in all developed and many developing countries (Omran 1998; Feinleib 2008).
  + With an increase in longevity, the population started shifting toward an older age structure (Popkin 2008).
* Disease: As the proportion of elderly in the population grew, chronic degenerative diseases became more prevalent (Omran 1998)
  + Medical and public health advances provided greater control over infectious diseases.
  + Low levels of physical activity compounded with diets high in total fat, cholesterol, sugar, and other refined carbohydrates but low in polyunsaturated fatty acids and fiber resulted in degenerative diseases such as obesity and other metabolic disorders (Popkin 2008).
  + Although a larger proportion of individuals are dying of degenerative diseases, the risk of degenerative mortality has not necessarily increased (Gage 2005). Eliminating infectious diseases necessarily increases the number and proportion of deaths attributed to the remaining causes such as degenerative diseases. Individuals may, therefore, simply be surviving long enough to die at older ages.
* Fertility: greatly declined in high-income populations (Omran 1998)
  + Income growth is associated with women becoming increasingly emancipated form traditional roles and becoming better educated. As a result, women were delaying reproduction.
  + Together with the spread of small family size norms, fertility greatly declined.
* Population: Throughout most of human history, the world population remained fairly stable, but since the Industrial Revolution, the population grew from about 1 billion in 1800 to over 7 billion in 2011 (Coale 1974; Bloom 2011).
  + This remarkably rapid population growth is a result of the time lag between declining mortality rates and reducing birth rates (Omran 1998). In populations that have undergone this second major demographic transition, declines in mortality always preceded declines in fertility (Coale 1974).
  + As some populations begin reducing birth rates, the rate of population growth is slowing, but the absolute population size will continue to grow.
* Issues of data quality, quantity, and interpretation
  + This second major demographic transition did not occur simultaneously throughout the world or even in different geographic regions within the same country (Gage 2005).
  + Conclusions drawn from available data, especially early on in the transition, are inherently biased toward the Western European experience (Feinleib 2008).
  + The demographic and epidemiologic transition experienced by the rest of the world is fundamentally different from the western transitions (Omran 1998).
    - By the time the non-western transition began, modern medical advances were already available.
    - As a result, reduction in mortality may occur later but more rapidly.