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<Keywords for your study>
Demographic transition, epidemiologic transition, life table, life expectancy (expectation of life), demographic model, age-standardized mortality, hazard

1. Introduction

-Evolutionary medicine: Health of organisms declines when they are introduced to novel environments (Nesse and Williams, 1999; Stearns, 1999). Theoretical arguments:
1. Development of agriculture negatively affected health of hunter-gatherers (due to poorer nutrition, increased population density). –also, skeletal remains
2. Modernization/industrialization/Westernization influence health negatively (diet, exercise)
-Several empirical evidences contested the above hypothesis

Purpose:
(1) Historical trends in mortality and cause of death with respect to the advent of agriculture, (2) How modernization in the last 150 years influenced health?

Definitions: "Health" will be defined as expectation of life or age-standardized death rates. "Modernization", "industrialization", "Westernization", and "cosmopolitan" will be defined loosely as the secular trends observed in Western Europe and United States. "Demographic Transition": trends in total mortality, "Epidemiologic Transition" trends in cause of death.

2. Source of Evidence

(1) Mortality and Morbidity records in European countries (e.g., 1722- Finland).
(2) Data of family reconstitution studies in England and Wales (available from 1541).
(3) Skeletal and Archaeological evidences.

- (1-1) Human Mortality Database (2004): Life tables for Sweden, for each year from 1751–2003. (1-2) Information on age-standardized trends in cause of death in the United States from 1900–1998: Center for Disease Control (CDC)/National Center for Health Statistics (NCHS) National Vital Statistics Systems. (1-3) Life tables decremented by cause of death for an international sample are taken from Preston et al. (1972); Disease specific life Tables for 165 populations in 43 countries. See Table 1 for "the classification of deaths by cause"

* potential problems:
- quality of data may change over time (diagnosis, enumeration)
- different age standard used for the calculation of age-standardized mortality,
→life expectancy or cumulative hazard

3. The Demographic Transition

Thompson (1929) first proposed the theory of the demographic transition, a descriptive model of secular declines in mortality, fertility, and consequent population growth that occurred following the industrial revolution.
- geographic variation in the timing (rural-urban, rural-rural)

3-1. Observed secular trends in total mortality

Stage-I: high mortality and fertility, with stationary or slow population growth. Mortality fluctuated (**Fig 1**): crisis mortality were notably found before 1850. The last of crisis mortality was found in 1918-19 due to influenza epidemic.
Stage-II & III: decline of "normal mortality". Stage III involves fertility decline. It began in less-developed countries in 1920s (**Fig 2**)
Stage-IV: After WWII in developed countries; slowing of mortality decline due to the fact that infant, childhood, and young adult mortality have reached a minimum.

Prehistoric life expectancy (skeletal estimates): 18-25 years, shorter than that found in Sweden in 1750 (Fig 1). Hunter-gatherers: 21.6 years (SD=2.1); horticulturalists: 21.2 years (SD=3.9); and agriculturalists: 24.9 years (SD=8.5); not statistically significantly different by the mode of subsistence.
→ Health did not deteriorated with the agricultural revolution.

3-2. Observed secular trends in age-specific total mortality

Fig 3: Age-specific mortality change in Sweden between 1751 and 2001.
** 1751-1851: less change except for the possible decline in childhood; 1851-1901: mortality decline in adults; 1901-1951: mortality decline among those aged 60 or younger; 1951-2001: mortality decline in all ages, particularly at age 50 years or older.

Fig 4: Age-specific mortality in Stage-I Sweden (1751) and Libben, a North American Late Woodland population (hunter-gatherer) ca. 800-1100 AD.
** similar until 5 years after birth; after 5 years or older: higher among hunter-gatherers.

Fig 5: Siler Model (1979) divides risk of death into **immature mortality** (which declines with age), **residual mortality** (which is constant with respect to age), and **senescent mortality** (which increases with age).

Fig 6: Gage (1994) examined the cumulative (lifetime) risk of mortality at ages 0–80 with respect to expectation of life in the sample by Preston et al. (1972) of cause-specific
life tables (Fig. 6). Altogether, about 50% of the decline in total cumulative risk of death across this sample is due to declines in **senescent mortality**. A little more than 25% of the decline in the cumulative hazard is due to declines in **immature mortality**. The remaining 25% declines as a **constant** (**residual mortality**) across all ages. Females tend to have slightly higher residual and slightly lower senescent mortality than males.

Fig 7: Stage-I residual mortality declined due to the decrease of crisis mortality; Stage II&III: decline of immature and senescent mortality; Stage IV: decline of residual and immature mortality

3-3. Summary: Demographic Transition

-total mortality has experienced a secular decline over the last 300 years in the developed nations. Timing of component-specific of decline varied.

4. The Epidemiologic Transition

Originally, the epidemiologic transition was defined in terms of the rank ordering of deaths by cause (Omran, 1977).
** POINT: "A larger proportion of individuals die of degenerative diseases today than in the past. This does not necessarily mean that the risk of degenerative death has increased. The reduction or elimination of one cause of death will, all other things being equal, increase the number and proportion of deaths attributed to the causes that remain. However, the age-specific risk of the remaining causes may not have increased. Individuals may simply survive longer and die at an older age."
○ age-specific risk of degenerative diseases
× total deaths due to degenerative diseases

4-1. Epidemiologic transition: 1861-1964

Fig 8: The age-standardized observed secular trends in total infectious, total degenerative, and other and unknown causes of death for England and Wales 1861–1964.
** Deaths categorized to "other and unknown" were gradually categorized in the named categories due to the improvement of diagnosis, possibly to that of degenerative diseases. Risk of degenerative diseases may not have increased over time.

Fig 9: All of the infectious disease categories declined.
Fig 10: Neoplasms fluctuate, but appear to have increased. CVD fluctuate and may have increased slightly. The others increased and then decreased.
** Neoplasms and CVD deaths paralleled the influenza epidemic (1890s)? Influenza killed the patients of

neoplasms and CVD? Death by neoplasms and CVD decrease after the influenza epidemic?

The risk of degenerative diseases could decrease or increase; because infectious causes declined faster than degenerative causes.

4-2. Epidemiologic transition 1861–1964: controlling for misclassification

**The studies that controlled for misclassification are consistent in concluding that the risk of cardiovascular disease, and of certain degenerative diseases, declined, while neoplasms increased with modernization (1861–1964).

Table 2: Y=cause-specific age-standardized death rate; X=all-cause age-standardized death rate (N=165, 1861-1964). Slope=%contribution of each cause (Y) to total (X).
Decline in overall death rate during the period of epidemiologic transition was explained by the increase of neoplasms (both sexes) and CVD (male) death rate. However, the largest components of change was explained by the decrease of death rate due to "other and unknown", which suggested the effect of the neoplasms and CVD are overestimated

Table 3: Cause-specific mortality change was divided into "components" of deaths (immature mortality, residual mortality, and senescent mortality), and regressed with all-cause mortality change after controlling the effects of misclassification (death rate due to "other and unknown" category and that of period.

Misclassified: Influenza, pneumonia, and bronchitis (senescent), neoplasms, CVD, and certain degenerative diseases (senescent)

Fig 11. After controlling the effect of misclassification, only the risk of neoplasms increased during the period of epidemiologic transition, while that of other degenerative diseases declined.

Fig 12

4-3. Epidemiologic transition: last half of the 20th century

In October 1978, the National Heart, Lung and Blood Institute of the National Institutes of Health sponsored a conference to consider the surprising finding that the risk of coronary heart disease mortality was declining (Havlik and Feinleib, 1979).

Fig 13. Age-standardized death rate due to CVD and heat diseases have declined since 1950s. Even that of neoplasms seems to have declined since 1990s.

4-4. Epidemiologic transition, age-specific: last half of the 20th century

-Since the 1950s, all causes have declined approximately equally in the population over 50 years of age (Salomon and Murray, 2002).

4-5. Summary: Epidemiologic Transition

** Point: The history of secular trends in cause of death depends on whether it is expressed as the proportional structure of cause of death (Omran, 1977) or as trends in the risk of cause of death. To answer the question of whether modernization is bad for health, it is the latter definition that must be employed. The studies presented above suggest that during the historical decline in mortality in England and Wales, the US, and other modernized countries, the risk of both infectious and degenerative causes of death declined.

5. Degenerative Disease Morbidity

In fact, all other things being equal, the higher the mortality of morbid individuals, the lower the prevalence of morbidity! (**Fig 14**)

5-1. Morbidity during the last half of the 20th century

-increased due to the faster decline of mortality than the increase of incidence.

5-2. Morbidity during the first half of the 20th century

- decreased?

5-3. Morbidity during the prehistoric period

- ?

5-4. Summary: morbidity

Decreased in the first half and increased in the latter half.

6. Why Did Infectious Disease Mortality Decline?

-largely unexplained (Hinde, 2003; Woods, 2000)

-Mckeown (1976) suggested (1) evolution of host-parasite interactions, (2) improvement in sanitation, (3) improvement in modern medicine, (4) improvements in nutrition and standard of living.

-a convincing and comprehensive explanation of the decline in infectious disease mortality is still not available.

7. Why Did Degenerative Disease Mortality Decline?

- possibility: (1) Changes in lifestyles; (2) Improvements in modern medicine; (3) Direct interactions with infectious diseases; (4) Indirect interactions with infectious disease mortality; and (5) Degenerative diseases are infectious diseases.

- decline of infectious diseases (?) (Fig 9&10)

- decline of early exposure to infectious diseases (?) (Barker, 1999)

8. Why has Human Mortality Declined in the Face of Novel Environments?

- Humans that have hunter-gatherer gene have not well adapted to the modern environment (Eaton and Easton, 1999). ←→ the author's finding in the present paper.

Hypothesis:

** Humans have modified the environment for their good survival?

e.g., sanitation, public health, chemotherapy

9. Conclusion

(1) Mortality before modernization > mortality after modernization (Fig 1 and other evidences).

(2) Mortality due to infectious diseases has declined during the process of modernization. The reason is unknown. (Fig 8, Fig 9)

(3) Mortality due to degenerative diseases has declined during the process of modernization. The commonly held concept that degenerative diseases increased until the mid-20th century is based on trends in cause of death that are uncorrected for misclassification of cause of death. (Tables 2&3, Fig 11).

Only mortality due to neoplasms has increased with modernization.

(4) Morbidity data is not always reliable. Degenerative diseases morbidity decreased in the first half and increased in the latter half of 20th century.

(5) Modern environment could be the one "built" by humans for the better survival.