Are Modern Environments Really Bad for Us?: Revisiting the Demographic and Epidemiologic Transitions

Dept Meeting on 20 Nov 2007, M. UMEZAKI

Timothy B. Gage*

Department of Anthropology and Department of Epidemiology, University at Albany-SUNY, Albany, New York 12222, and Department of Genetics, Southwest Foundation for Biomedical Research, San Antonio, Texas 78284

KEY WORDS demographic transition; epidemiologic transition; mortality; cause of death

ABSTRACT It is a common assumption that agriculture and modernization have been detrimental for human health. The theoretical argument is that humans are adapted to hunter-gatherer lifestyles, and that the agricultural and "modern" environments are novel and hence likely to be detrimental. In particular, changes in nutrition, and population size and distribution with the adoption of agriculture, are considered to increase the risk of infectious disease mortality. Similarly, changes due to modern lifestyles, notably changes in nutrition, smoking, exercise, and stress, are thought to be associated with an increased risk of degenerative disease mortality in the industrial environment. This paper reviews the available literature on the history and prehistory of total mortality (the demographic transition) and cause of death (the epidemiologic transition), and finds that neither agriculture nor modernization is associated with increases in mortality, i.e., declines in health. First, mortality does not appear to have increased during the transition to agriculture, or during the early phases of the industrial revolution. Clearly, infectious diseases have declined with modernization. Second, the empirical data, when uncorrected for misclassification of cause of death, do suggest an increase in degenerative disease mortality, at least until the mid 20th century, when these causes of death clearly began to decline. All studies that correct for misclassification of cause of death, however, find that the general decline in degenerative disease mortality began much earlier, perhaps as early as the 1850s in the developed countries. This is about the same time that infectious disease mortality began to decline in these countries. The exception is neoplasms, which increased with modernization until quite recently. Part of the increase in neoplasms may be attributable to increases in smoking during the course of modernization. Nevertheless, the overall risk of degenerative disease mortality appears to have declined with modernization. The fact that the decline in the risk of infectious disease mortality, and the decline in risk of degenerative disease mortality, are largely coordinated suggests that the causes of both declines may be related. Historical trends in morbidity, and potential causes of the decline in infectious and degenerative disease mortality, are briefly considered. Yrbk Phys Anthropol 48:96–117, 2005.

TABLE 1. Classification of deaths by cause[1]

Title	ICD7 codes	Definitions
Infectious causes of death		
Respiratory tuberculosis	B1	Respiratory tuberculosis
Other infectious and parasitic diseases	B2–17	Tuberculoses (other forms), syphilis, typhoid, cholera, dysentery, scarlet fever, diphtheria, whooping cough, meningococcal infections, plague, polio, smallpox, measles, typhus, malaria, and all other infectious diseases
Influenza, pneumonia, and bronchitis	B30–32	Influenza, pneumonia, and bronchitis
Diarrhea	B36	Gastritis, duodinitis, enteritis, and colitis (except diarrhea of newborn)
Certain diseases of infancy	B42–44	Birth injuries, infections of newborn, and other diseases due to infancy and immaturity
Degenerative causes of death		
Neoplasms	B18–19	Malignant and benign
Cardiovascular	B22, B24–29 A85, A86	Vascular lesions, rheumatic fever and heart disease, arteriosclerosis, other diseases of heart, hypertension, and diseases of arteries and circulatory system
Certain degenerative diseases	B20, B33, B37, B38	Nephritis, nephrosis, cirrhosis of liver, ulcers of stomach and duodenum, and diabetes
Miscellaneous causes of death		
Other and unknown causes of death	B46, B21, B23, B34, B35, B39, B41	All other diseases (except diseases of arteries, A85, and other diseases of circulatory system, A86), anemias, nonmeningococcal meningitis, appendicitis, intestinal obstruction and hernia, hyperplasia of prostate, and congenital malformations

[1] Adapted and abridged from Preston et al. (1972).

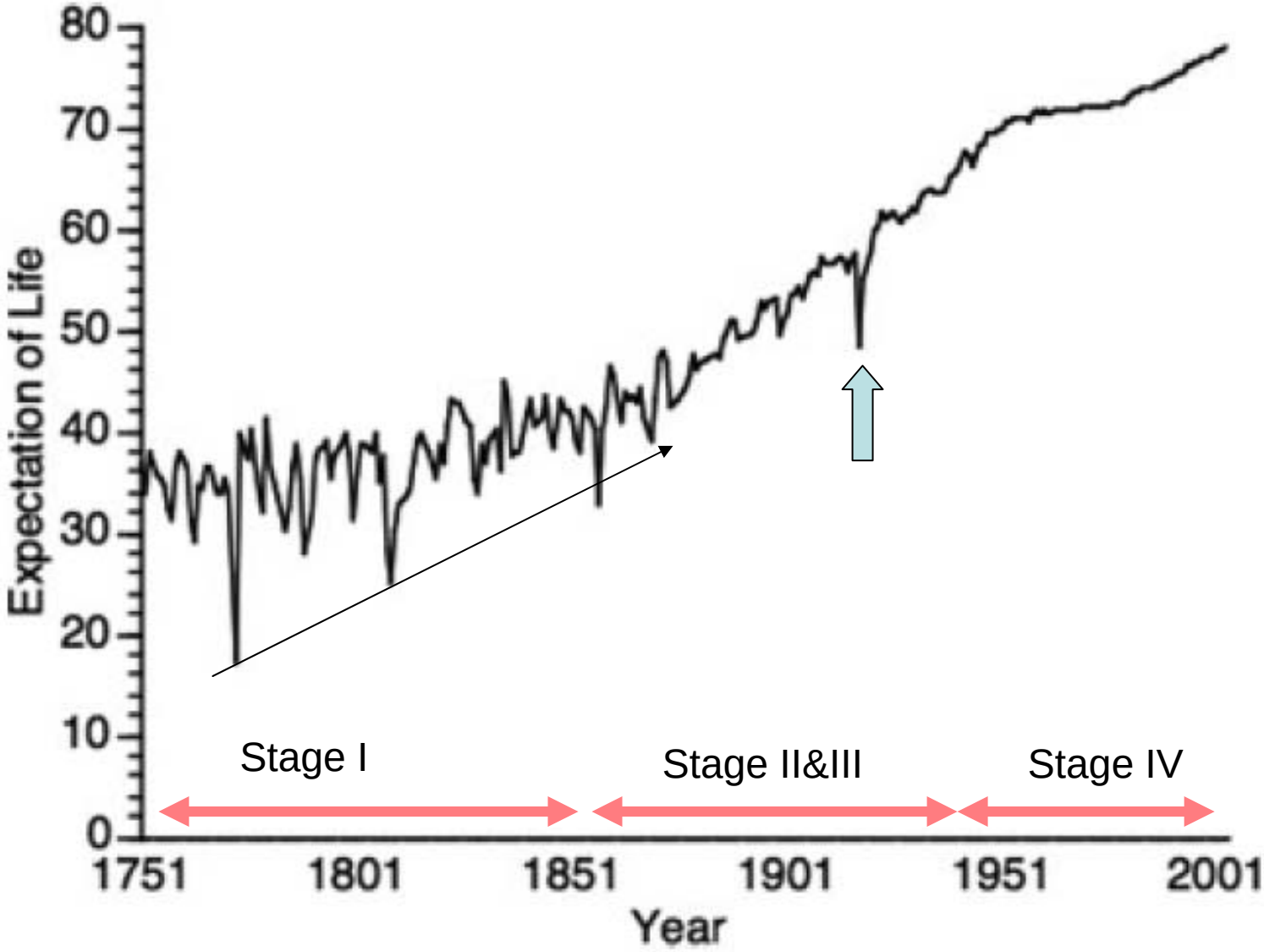


Fig. 1. Secular decline in mortality, as reflected by increasing life expectancy. Yearly estimates for 1751–2003 are from Sweden. Data source, Human Mortality Database, January 6, 2005.

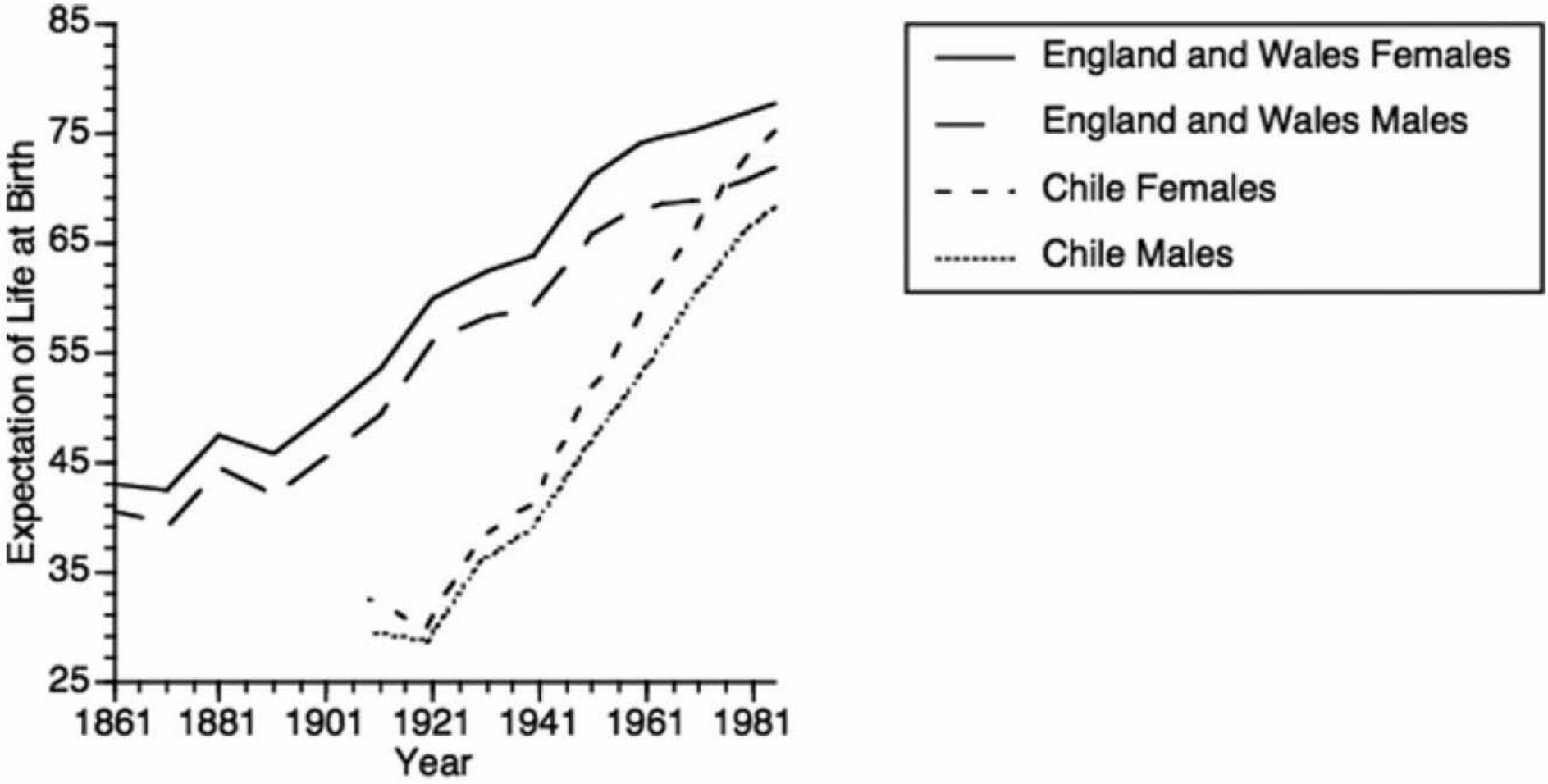
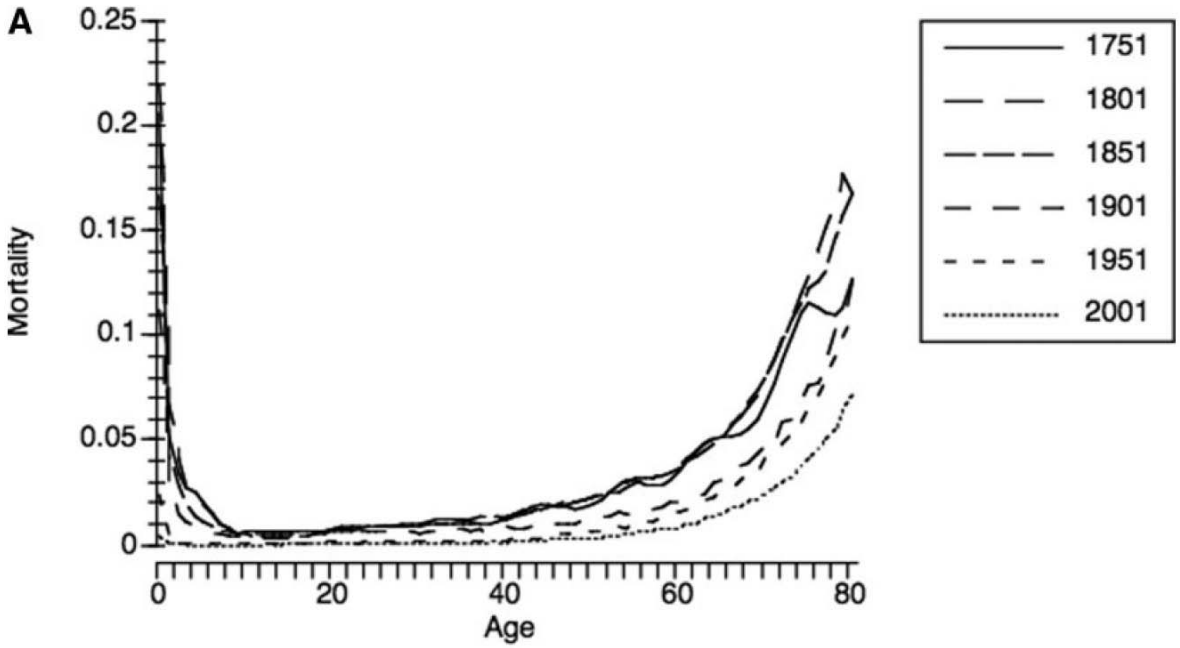
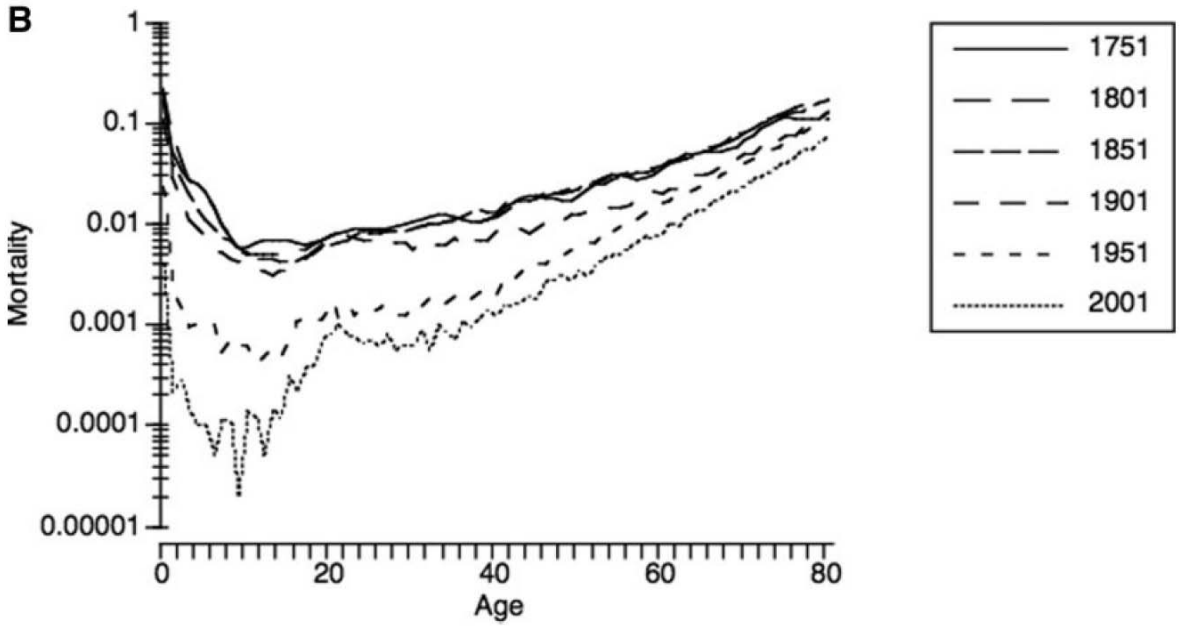


Fig. 2. Secular decline in mortality measured as expectation of life at 10-year intervals for developed nation (England and Wales) and developing nation (Chile). Data source is Preston et al. (1972). Figure reprinted from Gage (2000).

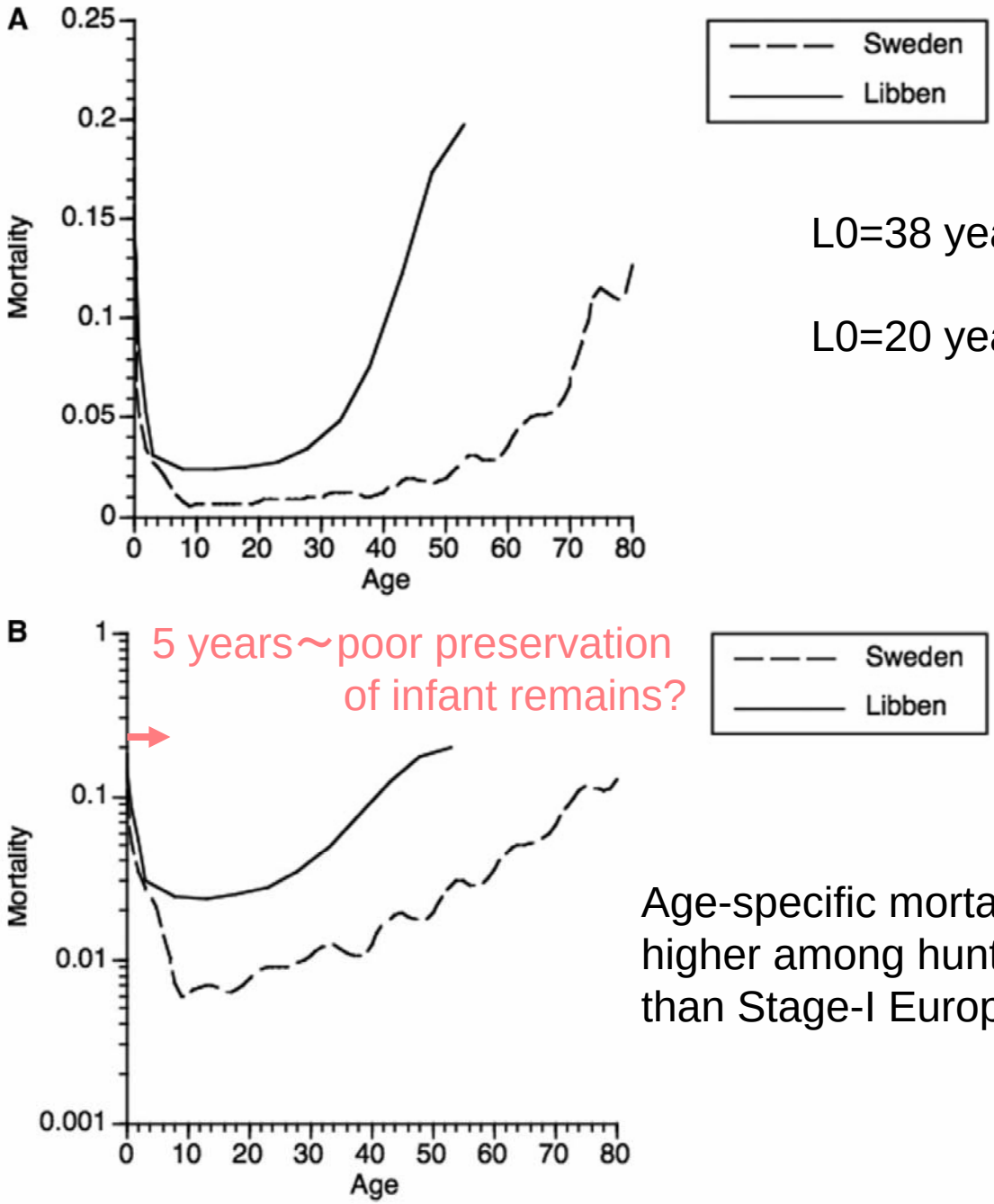


Sweden



Sweden

Fig. 3. Age-specific mortality rates for Sweden, 1751, 1801, 1851, 1901, 1951, and 2001, indicating secular changes in contribution of different ages to decline in mortality. **A:** Data on absolute scale. **B:** Same data, based on log of mortality. Data source, Human Mortality Database, January 6, 2005.

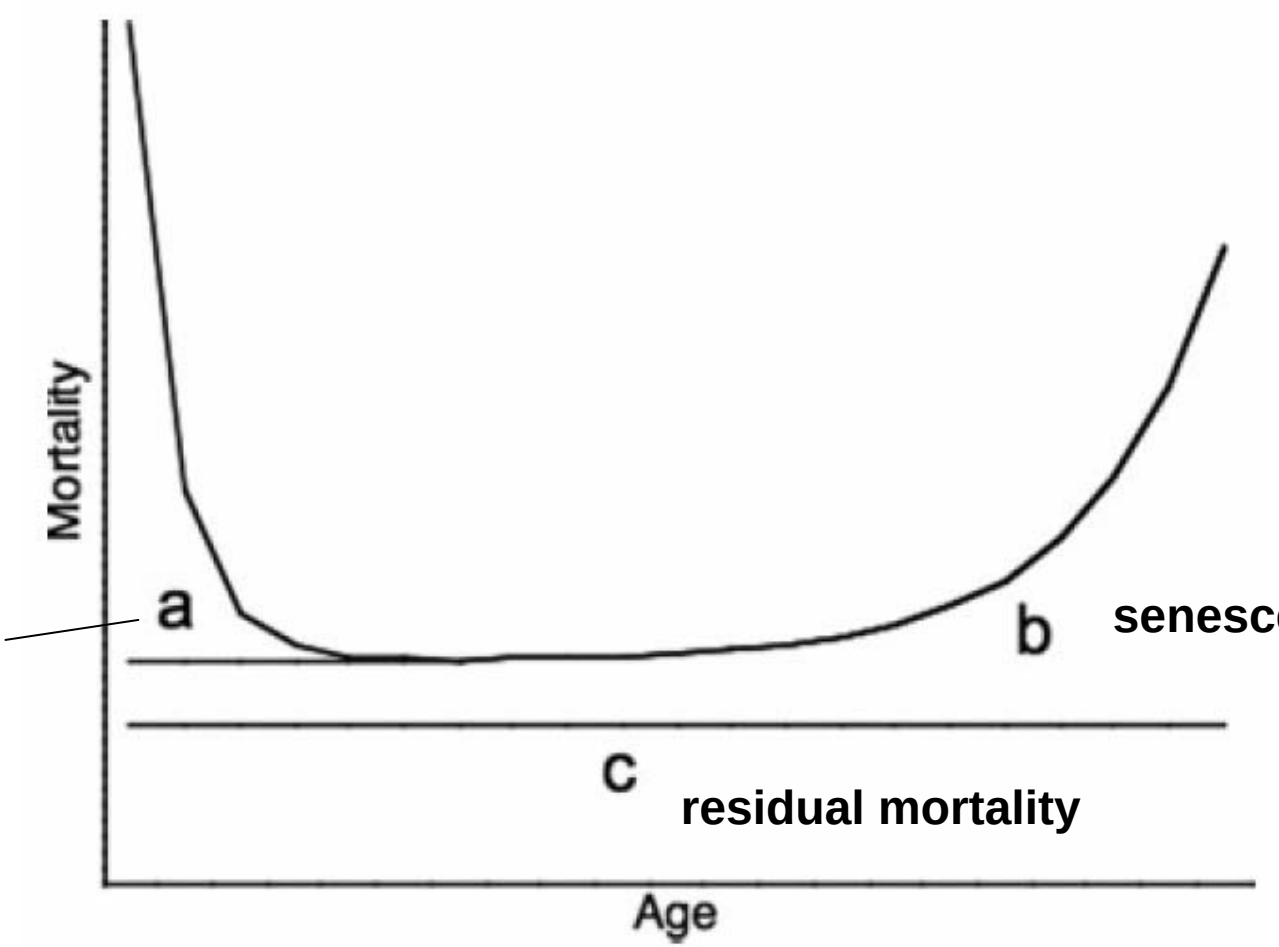


L0=38 years in Sweden

L0=20 years in Lidden

Age-specific mortality was higher among hunter-gatherers than Stage-I European population

Fig. 4. Age-specific mortality rates for Sweden, 1751, and Libben, a North American Late Woodland population (hunter-gatherer) ca. 800–1100 AD. **A:** Data on absolute scale. **B:** Same data, based on log of mortality. Data sources, Sweden (Human Mortality Database 6 January 2005); Libben life table reported by Lovejoy et al. (1977), smoothed by Gage (1988).

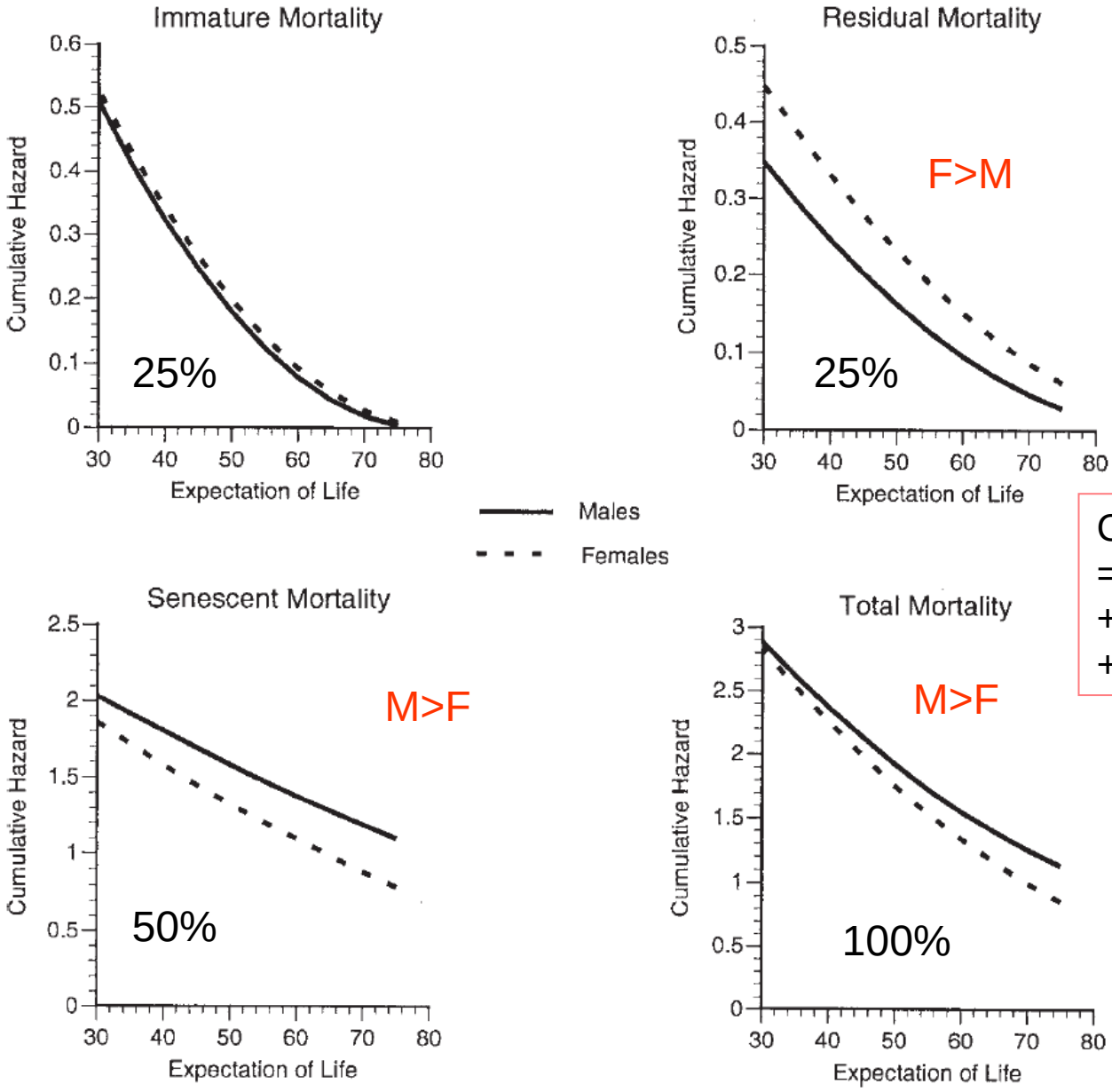


immature mortality

senescent mortality

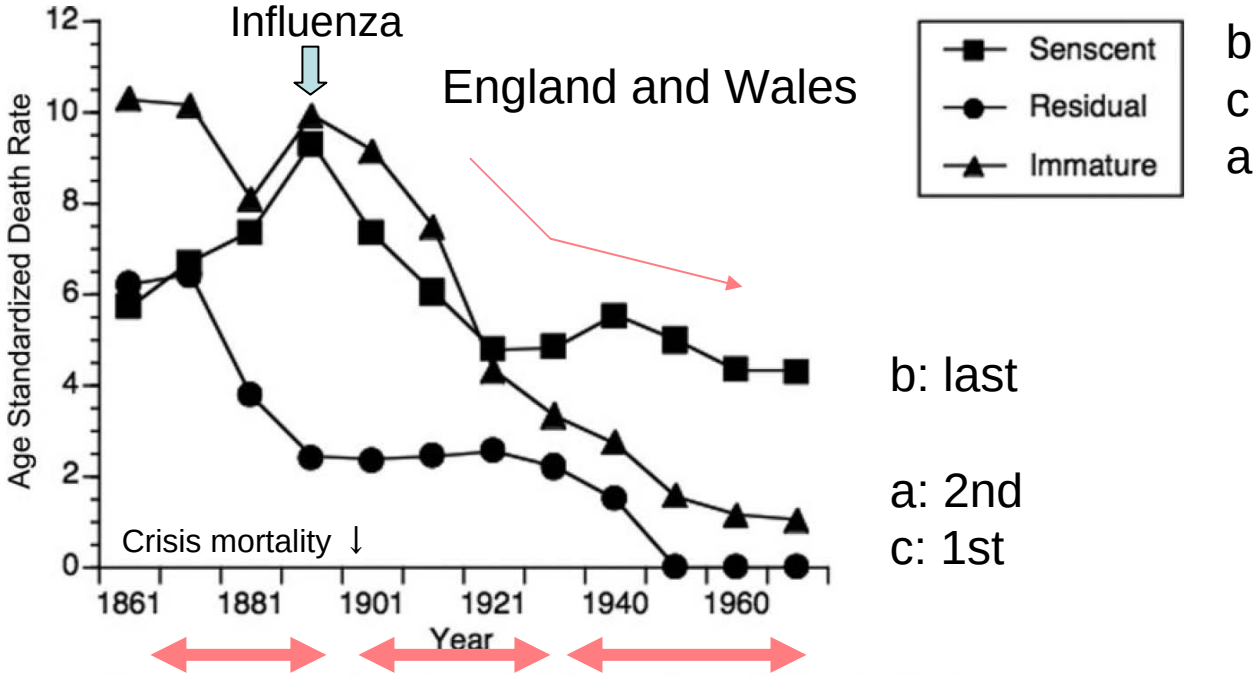
residual mortality

Fig. 5. Graphical depiction of model of age-specific mortality (Siler 1979). Model is sum of three components of mortality. Area "a" is immature component representing decline in mortality immediately following birth, area "b" is senescent component, representing increase in mortality with age, and bottommost area "c" is residual component representing age-independent, exogenous risks. From Gage (1991).



Change in expectation of life
=change in immature mortality
+change in residual mortality
+change in senescent mortality

Fig. 6. Decline in component-specific mortality as total mortality declines in sample of Preston et al. (1972). Results presented here statistically control for period (i.e., calendar year) effects. From Gage (1994).



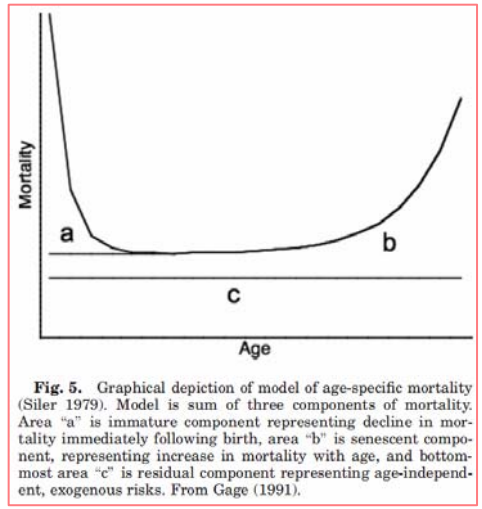


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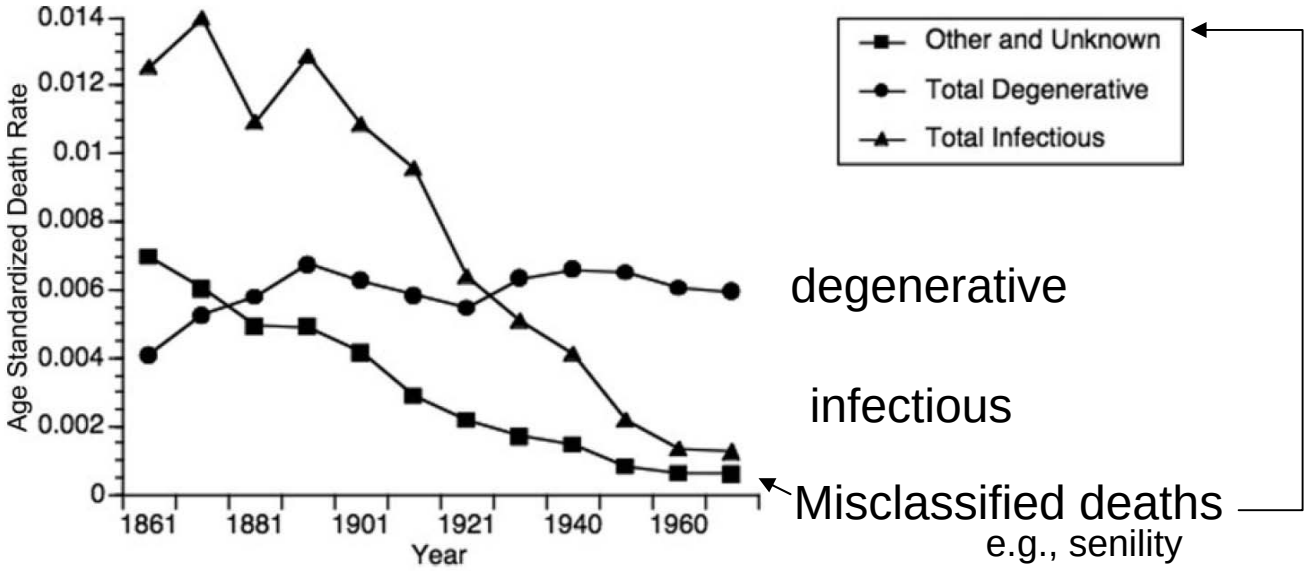
Fig. 7. Decline in component-specific mortality of Siler (1979) in England and Wales, 1861–1964. Data source, Preston et al. (1972). From Gage (1993).



Misclassified deaths

↓

degenerative

Decline of infectious diseases

|

Increase of degenerative diseases

Fig. 8. Decline in total infectious, degenerative, and other and unknown causes of mortality (as defined in Table 1) for England and Wales, 1861–1964. Data source, Preston et al. (1972).

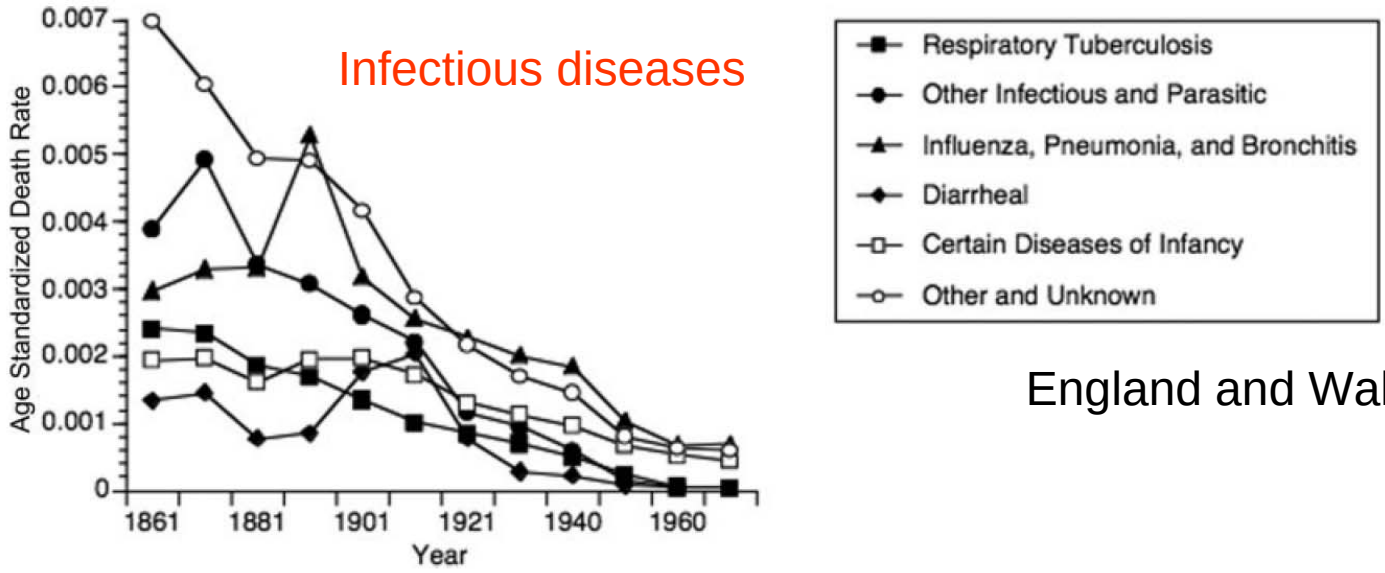


Fig. 9. Decline in named infectious, and other and unknown vauses of mortality (as defined in Table 1) for England and Wales, 1861–1964. Data source, Preston et al. (1972).

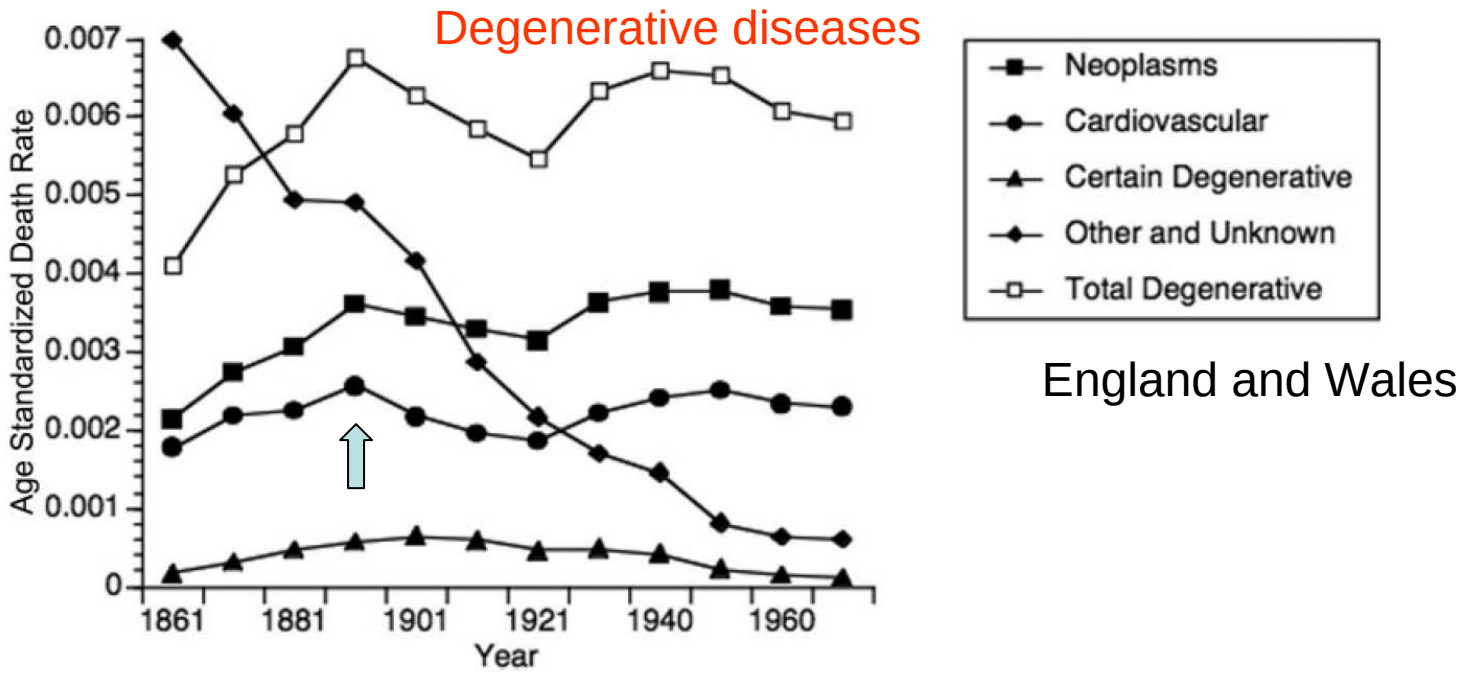


Fig. 10. Decline in named degenerative, and other and unknown causes of mortality (as defined in Table 1) for England and Wales, 1861–1964. Data source, Preston et al. (1972).

1861-1964?

TABLE 2. Regression of specific causes of death on overall death rate, all standardized for age structure[1]

Causes of death	Slope (correcting for misclassification) Males	Females
Respiratory tuberculosis	0.1188	0.1059
Other infections and parasitic diseases	0.1458	0.1398
Neoplasms	−0.0569	−0.0245
Cardiovascular	−0.0316	0.0179
	(0.2390)	(0.2456)
Influenza, pneumonia, and bronchitis	0.2831	0.2434
Diarrhea	0.1050	0.1041
Certain degenerative diseases	0.0206	0.0165
Certain diseases of infancy	0.0447	0.0422
Maternal		0.0197
Violence	0.0232	0.0041
Other and unknown	0.3475	0.3307
Sum	1.0002	0.9998

overestimation

[1] Slopes may be interpreted as % change due to cause. Positive regression coefficient (slope) indicates that i^{th} cause declines as all-cause mortality declines. Negative coefficient indicates that i^{th} cause increases as mortality declines. Preston (1976) only reported actual value of corrected slope for cardiovascular deaths. Adapted from Preston (1976).

TABLE 3. Sign and significance of regression coefficients for regressions of component-and-cause-specific deaths on total deaths, all standardized for age structure, based on the Siler Model[1]

Cause of death	Trend in cause of death as mortality declines[2]		Misclassification of cause of death	Period effect	R^2
	Males	Females			
All causes combined					
Immature	–	–	0	+	94.5%
Residual	–	–	0	–	64.3%
Senescent	–	–	0	0	73.7%
Respiratory tuberculosis					
Residual	–	–	0	–	73.2%
Senescent	–	–	0	+	47.1%
Other infectious and parasitic diseases					
Immature	–	–	0	–	89.2%
Residual	–	–	0	–	83.5%
Senescent	–	–	0	+	36.6%
Certain diseases of infancy					
Immature	–	–	0	0	71.9%
Residual	–	–	0	0	38.4%
Influenza, pneumonia, and bronchitis					
Immature	–	–	0	+	90.5%
Residual	–	–	0	0	72.9%
Senescent	–	–	&	–	74.3%
Diarrhea					
Immature	–	–	0	+	79.4%
Residual	–	–	0	0	53.0%
Senescent	–	–	0	0	59.6%
Neoplasms					
Immature	+	–	0	–	39.8%
Senescent	+	+	&	0	58.6%
Cardiovascular disease					
Immature	0	–	0	–	29.8%
Residual	–	+	0	0	17.7%
Senescent	–	–	&	0	39.9%
Certain degenerative diseases					
Immature	–	–	0	+	31.9%
Senescent	–	–	&	0	10.1%

[1] –, Cause of death declines as mortality declines or period increases; +, cause of death increases as mortality declines or period increases; 0, coefficient not significant; &, cause of death with significant numbers of misclassified deaths. Adapted from Gage (1994).
[2] Corrected for misclassification and period effects.

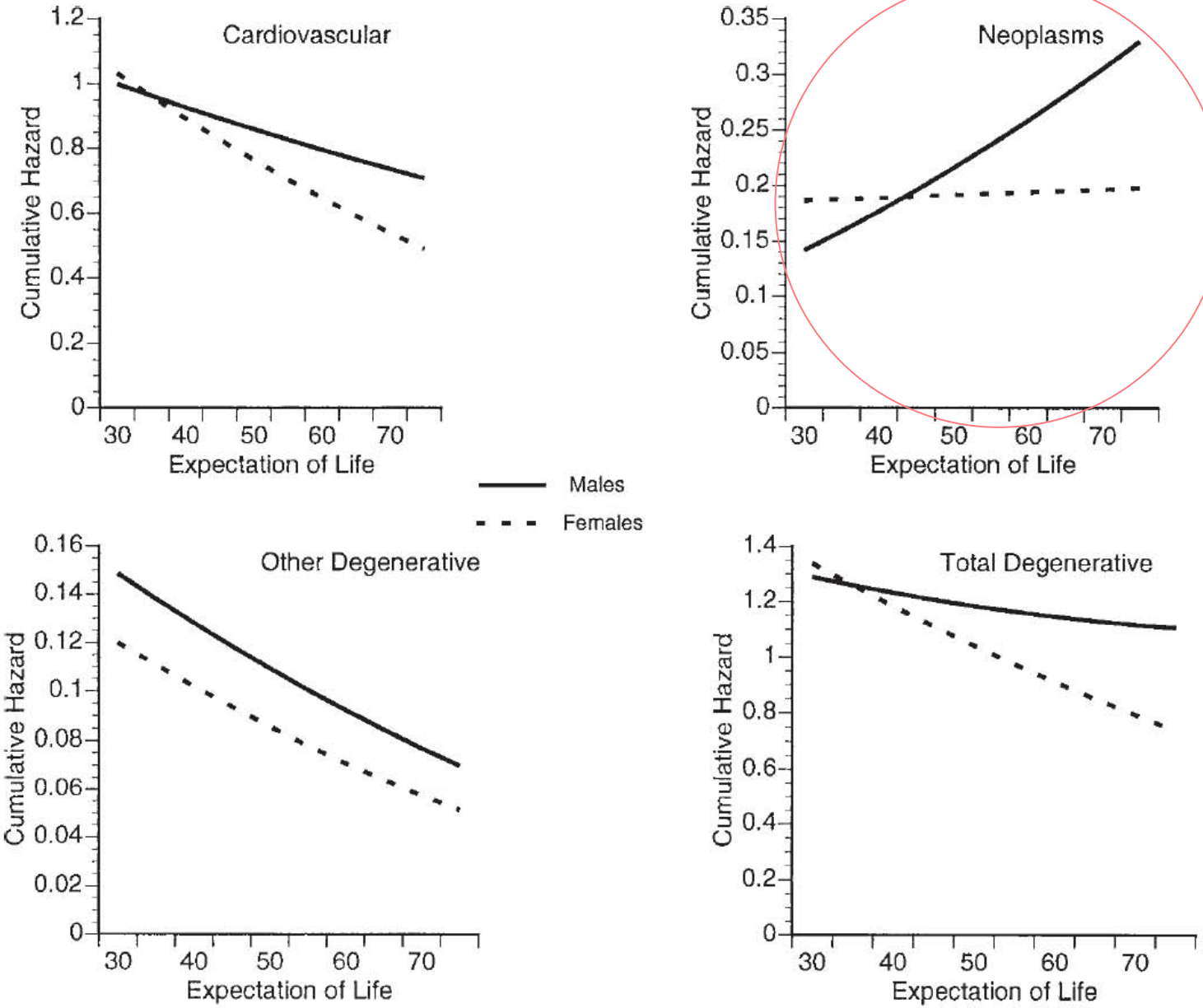


Fig. 11. Decline in cause-specific total degenerative mortality as mortality declines in sample of Preston et al. (1972), while statistically controlling for misclassification of causes of death and period effects. Decline in senescent degenerative mortality is very similar. Adapted from Gage (1994). Total degenerative mortality, represents the sum of cardiovascular, neoplasms, and certain degenerative deaths.

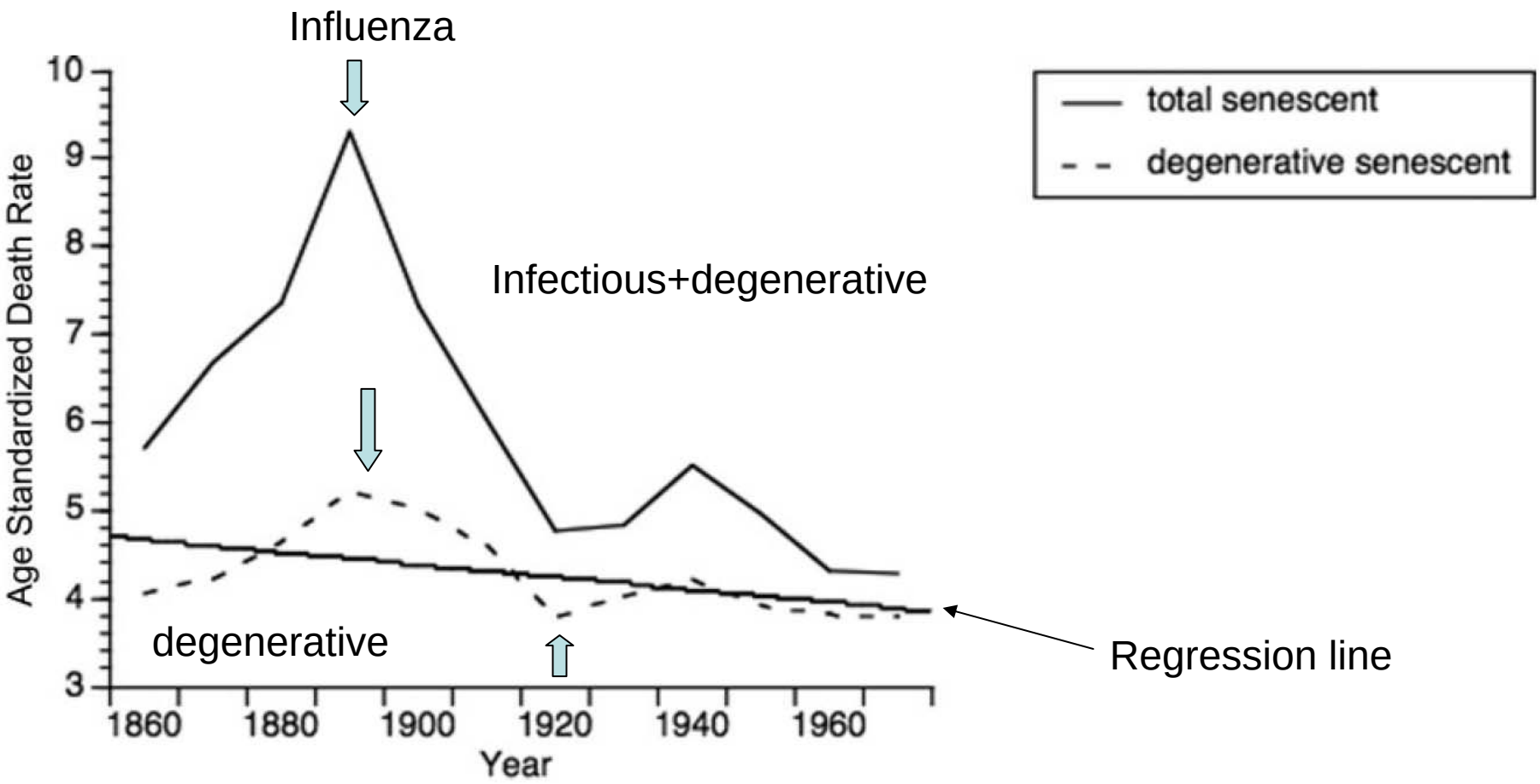


Fig. 12. Decline in senescent mortality in England and Wales 1861–1964, with and without infectious senescent causes of death decremented. Straight line is regression fitted to senescent degenerative disease mortality (i.e., senescent mortality with senescent infectious diseases decremented). From Gage (1993).

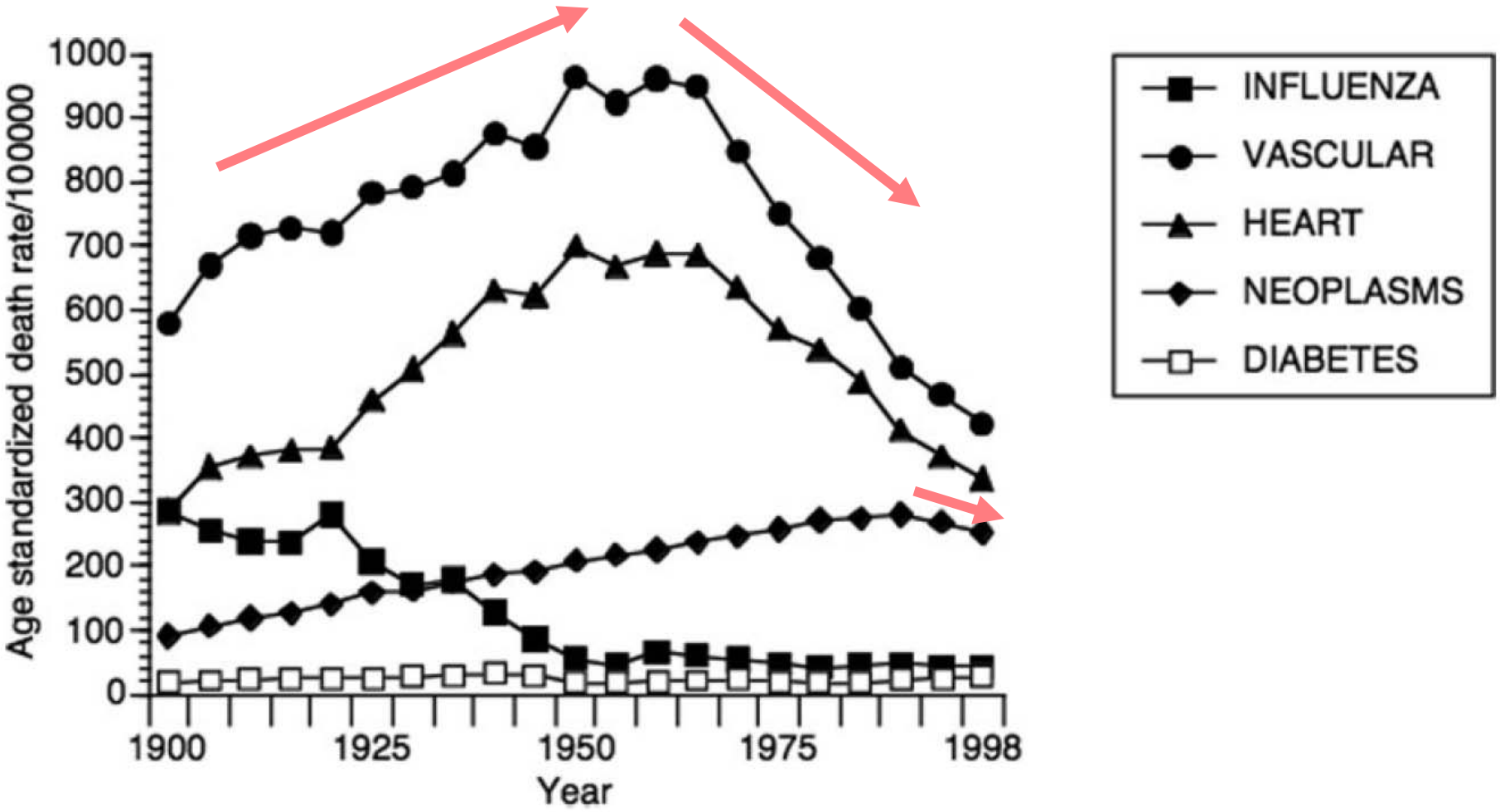


Fig. 13. "Rise" and fall of some degenerative diseases and influenza (cause responsible for largest decline in named infectious disease) in US male population from 1900–1998 (registration states, 1900–1932; US, 1933–1998). Age standardized to US 2000 age distribution. Data source: CDC/NCHS, National Vital Statistics System, Mortality, unpublished table HIST293.

USA, 1900-1998

Morbidity=Y-Z

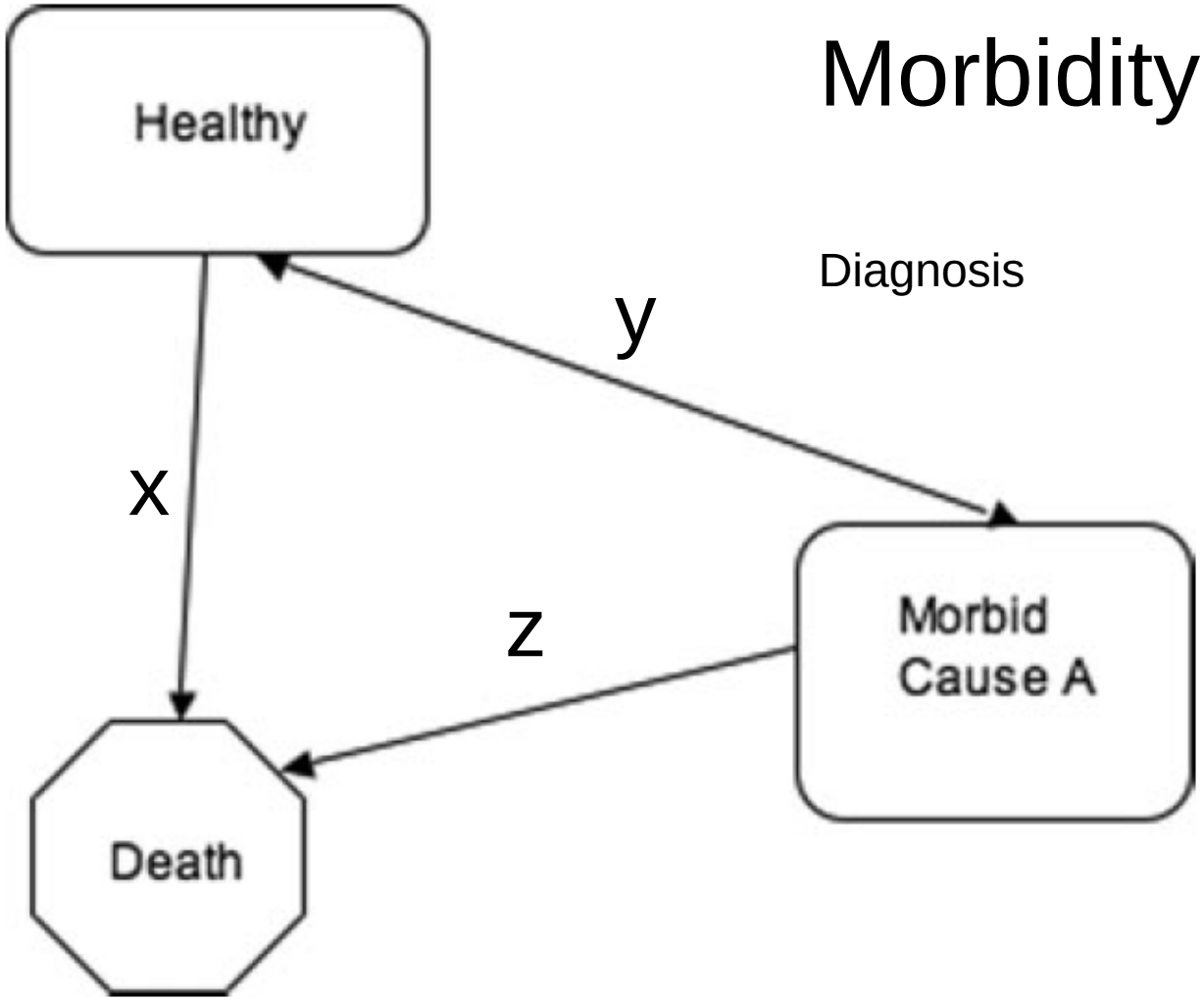


Fig. 14. Graphical depiction of relationship of cause-specific morbidity and mortality. Prevalence of morbid condition A is function of rate at which healthy individuals become morbid (incidence), and rapidity at which individuals morbid with cause A die (of cause A or any other competing cause).