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Ancient and early modern mortality: experience and understanding[1]

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This article discusses the various problems associated with the derivation of mortality measures for ancient Greece and Rome. It outlines two new sets of high mortality model life tables that describe the experiences of such populations more effectively than existing models. The issue of 'demographic borrowing' is also considered, particularly the use of early modern Europe and East Asia as sources for analogies, together with the ways in which the mortality component of historical demographic regimes has been represented and interpreted.

The late Keith Hopkins once wrote what he called a pessimistic, even gloomy, paper entitled 'Graveyards for historians'.[2] The source of his pessimism was his belief that despite the availability of some 43,000 ages at death recorded on Roman tombstones these inscriptions were not only a biased sample of all deaths, but the bias could not be corrected. Hopkins identified four sources of bias: age, place of residence, social class, and commemorative practice. Infants and young children were systematically under-represented. Urban rather than rural populations were favoured in a society with low levels of urbanization. The poor were significantly under-represented. Funeral monuments commemorated certain family relationships while neglecting others. In consequence, the gender ratio was biased in favour of males and there was a tendency for children to omit the ages of deceased parents on their tombstones. In short, commemorative practice was 'useless for understanding Roman patterns of death', and 'tombstone commemorations present us with demographically ludicrous conclusions'.[3] Hopkins was also critical of other forms of age-at-death evidence, especially that derived by archaeologists from the ageing of skeletal remains and that developed by Romans themselves for the calculation of the tax liability on annuities. On the former he suspected similarly substantial forms of age bias and on the latter he doubted the statistical sophistication of Roman

[1] I am grateful to seminar groups in Manchester, Oxford, and Cambridge for their valuable comments on earlier drafts of this paper, as well as to the Wellcome Trust for its support of a project on *Fetal Health and Mortality in the Past*, and to the Warden and Fellows of All Souls College, Oxford, for electing me to a Visiting Fellowship.

[2] Hopkins, 'Graveyards'. See also Hopkins, 'Probable age structure', which provides the original, detailed analysis of the age structure of the Roman population and, more recently, the if anything even more pessimistic re-evaluations by Scheidel, 'Roman age structure', and Scheidel, 'Progress', especially pp. 15–24.

[3] Hopkins, 'Graveyards', pp. 115 and 119.

lawyers.[4] Is it truly the case that 'many scholars have wasted much of their own and of their readers' time' in using such a source of demographic evidence?[5] Surprisingly, there was for Hopkins some light in the gloom. Model life tables and the set of reasonable expectations they provided of demographic experience offered this. Hopkins surmised that 'average expectation of life at birth in the Roman Empire as a whole was in the bottom half of our range of expectations, namely 20–30 years', and observed that these expectations 'are derived from model life-tables which are mathematical extrapolations, derived from all available historical and modern populations with good demographic statistics'.[6] These model life tables are the 'best demographic tools we have' although they can only provide a rough benchmark for the 'broad bands of probability, within which Roman demographic experience probably fell'.[7]

It is more than 20 years since 'Graveyards for historians' was first presented as a conference paper and more than 40 years since the Princeton model life tables became available. During this time there have been several important developments in demographic research—both theoretical and substantive—that offer new perspectives on Hopkins's arguments concerning the level of mortality experienced by the population of the Roman empire and the ways in which modern historians may understand that experience. First, it is now appreciated that the age pattern of mortality is more variable than was once believed, and that the variability also applies to historical populations. For example, the Princeton models do not summarize adequately all patterns, and any given population may move between mortality patterns during the centuries even when there is no substantial change in the overall level of mortality. This has encouraged the development of new sets of model life tables and alternative methods for their construction. Hopkins's confidence in the Princeton models may be misplaced, therefore.[8] Second, demographers have done more to define and examine the key age components in the mortality structure in detail and to link these with cause-of-death patterns, bringing together thereby demography and epidemiology. In particular, they have focused on infant and childhood mortality, on maternal mortality, and more recently on foetal mortality. Since studies of ancient Greece and Rome are bedeviled by questions of abortion, infanticide, and child abandonment, as well as the true extent of 'natural' early-

[4] Ibid., p. 120. These criticisms were directed against Frier, 'Ulpian's evidence', and Frier, 'Pannonian evidence'. See also Durand, 'Mortality', for an early, but still broadly relevant account.

[5] Hopkins, 'Graveyards', p. 113.

[6] Hopkins, 'Graveyards', p. 116. Hopkins outlined some of the principal features of the Princeton or the Coale and Demeny, *Regional model* system. However, Hopkins, 'Probable age structure', used the first (1955) United Nations system of model life tables, as did Osborne, *Demos*, pp. 43–44.

[7] Hopkins, 'Graveyards', p. 116.

[8] As we shall see, Scheidel has made some especially important contributions to the critique of how 'standard model life tables' (meaning principally the Coale and Demeny (Princeton) models) have been used by historians and historical demographers. Scheidel, 'Progress', offers an excellent introduction, as do the other contributions to Scheidel, ed., *Debating Roman demography*.

age mortality, any advance in the ability to derive estimates of child from adult mortality must be welcomed. Third, the substantive findings of new evidence-based research have enhanced demographic knowledge about pre-modern and especially early modern societies in various parts of the world. The notion of culturally embedded demographic regimes has become an extremely powerful one, to which has been added the assumption that meaningful analogies may be drawn between regimes that appear to be similar in their essential structure, but where one is well documented and the other far less so.[9] This practice of 'demographic borrowing' can offer considerable potential for work on ancient populations, but it is clouded by arguments over 'uniformitarian theory' and the extent to which modern, historic, and prehistoric populations may be compared.[10] This article will consider each of these three issues in turn.

I

While Hopkins was sceptical about the age at death data provided by tombstone inscriptions and skeletons, he was remarkably upbeat on the capacity of the Coale and Demeny (Princeton) model life tables to capture the age-specific mortality patterns of high mortality populations. He favoured, apparently for good reason, the model rather than the evidence-based approach. However, it is well known that the Princeton models are themselves empirically based, but that they depend on a collection of life tables from the late nineteenth and twentieth centuries, which are overwhelmingly European in origin. Indeed, all of the 23 life tables (out of 326 in total) dating from before 1870 are European and none of them has a life expectancy at birth ($e(0)$) less than 35 years. The Princeton model age-specific mortality patterns ($q(x)$) that relate to $e(0)$s in the range 20 to about 40 are essentially extrapolations from the patterns found among populations with substantially higher life expectancies at birth.[11] While there is nothing

[9] Biographers face the same problem; as Lee, *Body parts*, p. 25, reminds us, they are often obliged 'to proceed by ingenious analogies'.

[10] See, for examples, Howell, 'Uniformitarian theory', and, for an early 'borrowing', Hansen, *Demography*, p. 11. The latter argues that Princeton Model West level 4 ($e(0)$ for males of 25.26 years) combined with an annual population growth rate of 0.5% provides a 'proper analogy' for the demographic experience of Athenians in the fourth century BC—proper in the sense that this would make Athens analogous to ancient Rome since 'no expert on demography can any longer accept the demographic structure of Europe *c.*1850 as a proper model for ancient and medieval societies'. Scheidel, 'Creating a metropolis', also provides an excellent example in its use of early modern London and Tokugawan Edo in order to consider the growth of Ptolemaic Alexandria, together with what Scheidel calls 'theoretical predictions and comparativist analogies' (p. 30).

[11] This point has been emphasized by Parkin, *Demography*, who also observes, 'But there is every reason to believe that the demographic patterns of age structure and mortality trends that the Coale-Demeny tables illustrate are broadly applicable to ancient populations, and are at any rate the best sources of information available' (p. 81). Sallares, *Ecology*, p. 237, takes the opposite view that because Coale and Demeny sifted out the life tables of populations with high levels of tuberculosis mortality the Princeton models are not appropriate for historical populations. Sallares, *Malaria*, especially pp. 167 and 283, makes the point even more forcefully.

inherently wrong with this estimation procedure, it would obviously be beneficial to have more empirically based life tables for high mortality populations, especially if their reliability could be demonstrated. It would also be helpful to historians and historical demographers if new sets of high mortality, low life expectancy models could be developed that would be capable of representing the experiences of societies with $e(0)$s of less than 40. These are not forlorn hopes; they can run together, but they will require certain amounts of speculation and assumption, as well as imaginative use of what data are available.[12]

The work of Preston on cause-of-death structures and a range of new model life tables provides essential reference points.[13] The volume *Causes of death* (1972) gives examples of at least two early twentieth-century populations with $e(0)$s of less than 30 years—Chile and Taiwan (Formosa, then part of the Japanese empire)—for which there are also data on the principal causes of death.[14] Life tables for these populations can provide bases, or standards, upon which to develop series of high-mortality models. 'New model life tables' reports the construction of a set of models based on the mortality experience of freed American slaves who migrated to Liberia in the late nineteenth century. It demonstrates the potential of a method devised by Brass for the estimation of relational model life tables.[15] Brass's two-parameter approach involves estimating the association between the mortality profile of an observed population and that of a standard chosen to reflect the general age pattern of mortality believed to apply in the population under investigation. The goodness of fit is given by R^2, while the first parameter *alpha* expresses the level of mortality in the observed population compared with the standard and the second parameter *beta* measures the balance between child and adult mortality. Table 1 shows some examples drawn from *Causes of death*, as well as other high-mortality populations. It uses a combination of Chile 1909 and 1920 for females selecting the highest probability of dying at each age x ($q(x)$) from the two years as the first standard. The second standard is Taiwan 1920, again for females. Italy

[12] It is now common practice to be critical of the Princeton models, and then to use them as though they are a 'necessary evil'. See, for examples, Scheidel, 'Roman age structure', p. 25; *idem*, *Death on the Nile*, pp. 141 and 179; *idem*, 'Human mobility I', p. 2; and many other occasions.

[13] Preston, Keyfitz, and Schoen, *Causes of death*, and Preston, McDaniel, and Grushka, 'New model life tables'.

[14] In both cases it is generally agreed that the quality of vital statistics was reasonably good. United Nations, *Model life tables*, pp. 286–7, assesses the Chilean registration system. Preston, Keyfitz, and Schoen, *Causes of death*, p. 27, say that for Taiwan the 'Registration system held to be very good overall, although infant mortality underreported and child (1–4 years) mortality exaggerated'. They echo the assessment by Barclay, *Colonial development*, pp. 133–72, who showed that $e(0)$ was also about 28 years in 1906, although it had risen into the low thirties by 1909–11.

[15] Brass, 'Scale of mortality'. For a discussion of the various mortality models, see Anson, 'Model mortality patterns', and for a recent re-appraisal of the logit life table system, see Murray et al., 'Modified logit life table system'. One of the best introductions to these techniques is provided by Newell, *Methods and models*, pp. 151–66. It is strange that while ancient historians have noted the existence of 'New model life tables', they have not used them, nor have they explored *Causes of death* or Brass's work in general.

Table 1. *The fit of life tables to two model standards*

Population	*e(0)*	*alpha*	*beta*	R^2%
South Europe (SE)				
Chile 1909, 1920 standard	28.2			
Yanomama Indians	20.7	0.1870	1.3186	99.26
Roman Empire	21.1	0.1664	1.3856	99.25
'Florence'	22.4	0.1993	1.9264	97.85
Slaves 1820–32	22.8	0.0863	1.4772	98.71
Roman North Africa	23.2	0.1917	0.8094	94.29
Ancient Greece	24.4	−0.0126	1.9805	90.97
Pistoia 1427	29.0	−0.2163	1.4913	94.04
Italy 1881	34.0	−0.1478	0.9000	99.17
UN Chilean	35.0	−0.2189	1.0359	99.71
Portugal 1920	38.7	−0.2485	0.8282	99.10
East Asia (EA)				
Taiwan 1920 standard	29.2			
South China 1929–31	21.2	0.7981	1.3589	98.91
UN Far Eastern	35.0	−0.2213	1.1705	99.67
UN South Asian	35.0	−0.1320	0.8741	98.10
Japan 1899	43.7	−0.3749	0.8417	99.70

Notes: $e(0)$ is life expectancy at birth in years. See text for explanation of *alpha* and *beta*.
Sources: Yanomama Indians of South America (males and females): Neel and Weiss, 'Genetic structure', pp. 36–7; Roman Empire (males and females): Frier, 'Ulpian's evidence', p. 245 (with Princeton Model West level 2 up to age 15); 'Florence' (developed from Ulpian): Dupâquier, 'Sur une table', p. 1068; Slaves 1820–32 (males and females): Roberts, 'Life table', p. 242 (a life table with conventional age groups has been derived from the one reported by Roberts); Roman North Africa (females): Frier, 'Demography', p. 792 (with Model South level 2 up to age 10); Ancient Greece (males): Sallares, *Ecology*, p. 110 (based on Angel, 'Length of life', 'Paleodemography', and 'Health'); Pistoia 1427 (males and females): Herlihy, *Pistoia*, pp. 283-8; South China 1929–31 (females): Barclay, Coale, Stoto, and Trussell, 'Reassessment', p. 620; UN Chilean, Far Eastern, and South Asian (females): United Nations, *Model life tables*, pp. 97, 181, and 139; remainder for females from Preston, Keyfitz, and Schoen, *Causes of death*, pp. 146, 150, 386, 418, 578, 702.

1881, Portugal 1920, and Japan 1899 have good fits to the respective standards (over 99 per cent), encouraging the belief that they can be used to develop models with $e(0)$s in the thirties, but the other examples correspond far less well with Chile or Taiwan. The worst case is the life table for ancient Greece, which is based on skeletal data collected by Angel. Here it is clear that the age pattern of mortality is so irregular that it falls some way short of being credible. The life table for Roman North Africa also has a relatively poor fit. In this case tombstone inscriptions have been used. That for the Pistoia region of Italy in 1427 is also rather poor.[16] The other life tables have a reasonably good fit, indicating that their shapes bear a tolerable likeness to what may be expected, although this does not necessarily mean that the estimated level of mortality (indicated here by $e(0)$) must be entirely accurate. The life tables for 'Florence' and South China owe their existence to the ingenuity of statistical demographers, while that for the Caribbean slave population has also required some important assumptions to be made

[16] Herlihy, *Pistoia*, pp. 85–93 and 283–8, has seriously underestimated the level of early-age mortality, but makes some interesting comparisons with Roman life expectancies derived from Burn, '*Hic breve vivitur*'.

about the extent of early-age mortality.[17] None has been derived directly and exclusively from age at death and population at risk data in the manner now conventional among actuaries. Table 1 also uses three models devised by the United Nations to reflect $e(0)$s of 35 years.[18] As would be expected, the UN Chilean pattern matches the shape of our Chile standard closely, while there is a better fit between the Taiwan standard and UN Far Eastern than UN South Asian.

On the strength of table 1 and with the aid of the Brass system two sets of relational model life tables have been derived. The first, called South Europe (SE) for convenience, is based on the Chile standard and has 'Florence' and Portugal to mark lower and higher $e(0)$s.[19] The second, called East Asia (EA), uses Taiwan as standard with South China and Japan to guide the estimation of lower and higher life expectancies. These sets are shown in tables 2 and 3, respectively. They are arranged by $e(0)$s of 20, 25, 30, 35, and 40 years and display the survivorship function ($l(x)$), that is the numbers surviving to exact age x out of 10,000 'births'. Various other demographic indices, including the infant ($q(0)$) and early childhood ($q(1–4)$) mortality rates (per 1,000), are given at the bottom of the tables.[20]

Hopkins, along with his supporters and even his critics, came to the view that life expectancy at birth in the Roman empire was about 25 years.[21] They tend to use Princeton Model West level 3 to describe the age-specific mortality pattern and as a tool for the examination of other

[17] John, *Plantation slaves*, pp. 76–120, offers a highly sophisticated mathematical approach to the estimation of slave mortality, but it also has severe problems with deaths at early ages.

[18] United Nations, *Model life tables*. The lowest life expectancy at birth employed in this model system is 35 years. This is the second (1982) United Nations system of model life tables constructed for developing countries, the first was produced in 1955.

[19] Herlihy and Klapish-Zuber, *Tuscans*, pp. 270–4, have analysed the available mortality data for Florence in 1427. Assuming that it had an approximately stationary population in 1427 (a non-plague year) then its $e(0)$ was probably about 25–7 years, which is a little higher than that in the life table developed in Dupâquier's, 'Sur une table', which may owe its original empirical base more to Ulpian's 'evidence' than the conditions prevailing in early sixteenth-century Florence. 'Florence' is a combination of high mortality patterns, therefore.

[20] Although the principles laid down by Brass for the construction of relational model life tables are widely accepted when applied to the estimation of missing values or the correction of biases because of age misreporting, the derivation of sets of models usually requires a certain amount of iteration. This is noted by Preston, McDaniel, and Grushka, 'New model life tables', and by INDEPTH Network, *INDEPTH*, which offers new model life tables for Sub-Saharan Africa, developed to allow for the impact of the HIV/AIDS pandemic on both the level and age structure of mortality.

[21] See, for example, Hopkins, *Death and renewal*, p. 225; Garland, *Greek way of life*, pp. 106 and 108; Parkin, *Demography*, p. 80; and Saller, *Patriarchy*, pp. 12–25. Frier, 'Ulpian's evidence', p. 244; and Bagnall and Frier, *Roman Egypt*, p. 34, prefer Model West level 2 which has an $e(0)$ of 22.5 years, although Hopkins, 'Brother-sister marriage', p. 319, uses a model with an $e(0)$ of 20. See also Frier, 'Demography', p. 789. Scheidel, 'Measuring sex, age and death', p. 118, uses Model West level 4 for males in his work on the Roman army, although, as we have already noted, his later work is critical of the Princeton models. Hopkins also favours an infant mortality rate of 280 per 1,000 for the Roman empire. Frier, 'Ulpian's evidence', p. 249, mentions 'an infant mortality rate of 466.9 per thousand', but he means an infant death rate. His infant mortality rate ($q(0)$ per 1,000) for the Roman empire is 358.5. It may seem trivial to mention this mistake, but 466.9 is quoted by, for example, Scobie, 'Slums', p. 399.

Table 2. *South Europe (SE) high mortality model life tables (l(x))*

Age x	*e(0) = 20*	*e(0) = 25*	*e(0) = 30*	*e(0) = 35*	*e(0) = 40*	*Standard e(0) = 28.2*
0	10,000	10,000	10,000	10,000	10,000	10,000
1	6,900	7,100	7,250	7,494	7,718	6,980
5	5,065	5,751	5,930	6,422	6,900	5,731
10	4,573	5,437	5,536	6,228	6,672	5,427
15	4,319	5,204	5,380	6,084	6,551	5,259
20	3,929	4,836	5,133	5,852	6,357	4,996
25	3,409	4,321	4,783	5,519	6,076	4,616
30	2,889	3,788	4,413	5,159	5,768	4,214
35	2,451	3,295	4,058	4,806	5,462	3,835
40	2,061	2,845	3,718	4,461	5,158	3,478
45	1,735	2,449	3,404	4,135	4,865	3,151
50	1,443	2,084	3,095	3,808	4,565	2,830
55	1,179	1,739	2,783	3,469	4,248	2,513
60	941	1,416	2,465	3,117	3,908	2,181
65	678	1,046	2,059	2,655	3,447	1,760
70	404	643	1,536	2,035	2,793	1,265
75	183	303	963	1,323	1,974	755
80	64	109	503	717	1,191	370
85	15	28	208	308	582	140
$e(1)$	28.7	33.5	40.2	45.7	51.2	39.3
$e(5)$	32.4	36.9	44.7	49.0	53.0	43.4
$e(10)$	30.6	33.9	42.7	45.4	49.7	40.6
$e(20)$	24.7	27.4	35.6	38.0	41.9	33.7
$e(50)$	14.5	15.2	19.5	20.4	22.4	18.6
$q(0)$	310	290	275	251	228	302
$q(1–4)$	266	190	182	143	106	179

Note: Developed from Chile 1909 and 1920 for females as the standard population.
See text for explanation.

demographic implications, such as the average length of married life.[22] Figure 1 compares Model West with the South Europe and East Asia models using $q(x)$. It shows that there are important differences in terms of childhood and old age mortality, but especially mortality in early adulthood between the ages of 15 and 50. However, figure 1 is not able to summarize some of the most important differences in terms of mortality structures. This is done more effectively by figure 2. Here we can see what happens to infant mortality ($q(0)$ per 1,000) and to adult mortality ($e(20)$ in years) as life expectancy at birth ($e(0)$) increases from 15 to 45 years. The shaded scimitar-like shape in figure 2(a) indicates the extent to which the infant mortality rate changes and varies within the Princeton model

[22] Hopkins, 'Age at marriage', p. 325; and 'Probable age structure', p. 260. Hopkins and Beard, *Colosseum*, p. 88, argue that $e(17)$ for a 'normal' Roman male was 31 years whereas that for a gladiator just beginning his career at 17 was only 5.5 years. Hopkins has taken the $e(17)$ from Princeton Model West level 3 for males. The South Europe model in table 2 would place $e(17)$ at a lower level, 25–7 perhaps, given an $e(0)$ of 25. Harris, 'Hopkins', p. 103, notes that these calculations were Hopkins's contribution to the study.

Table 3. *East Asia (EA) high mortality model life tables (l(x))*

Age x	*e(0) = 20*	*e(0) = 25*	*e(0) = 30*	*e(0) = 35*	*e(0) = 40*	*Standard e(0) = 29.2*
0	10,000	10,000	10,000	10,000	10,000	10,000
1	7,567	7,737	7,849	8,191	8,450	7,904
5	5,412	5,962	6,485	6,972	7,414	6,384
10	4,789	5,433	6,039	6,592	7,084	5,922
15	4,491	5,175	5,818	6,402	6,918	5,694
20	4,072	4,803	5,495	6,122	6,670	5,362
25	3,537	4,316	5,062	5,739	6,327	4,918
30	2,995	3,800	4,590	5,314	5,939	4,437
35	2,482	3,289	4,105	4,863	5,520	3,945
40	2,061	2,847	3,668	4,447	5,124	3,506
45	1,720	2,470	3,281	4,066	4,754	3,119
50	1,421	2,124	2,911	3,692	4,382	2,752
55	1,134	1,773	2,520	3,282	3,965	2,367
60	860	1,418	2,104	2,829	3,491	1,961
65	607	1,066	1,665	2,328	2,948	1,538
70	379	721	1,203	1,768	2,313	1,098
75	214	445	801	1,246	1,691	721
80	92	218	433	727	1,036	383
85	21	62	146	275	419	125
$e(1)$	25.7	31.3	37.0	42.3	46.5	35.8
$e(5)$	31.2	36.0	40.9	45.3	48.7	40.0
$e(10)$	29.9	34.3	38.8	42.8	45.9	37.9
$e(20)$	24.2	28.1	32.1	35.6	38.4	31.3
$e(50)$	14.7	15.9	17.7	19.3	20.6	17.4
$q(0)$	243	226	205	181	155	210
$q(1–4)$	285	229	184	149	123	192

Note: Developed from Taiwan 1920 for females as the standard population.
See text for explanation.

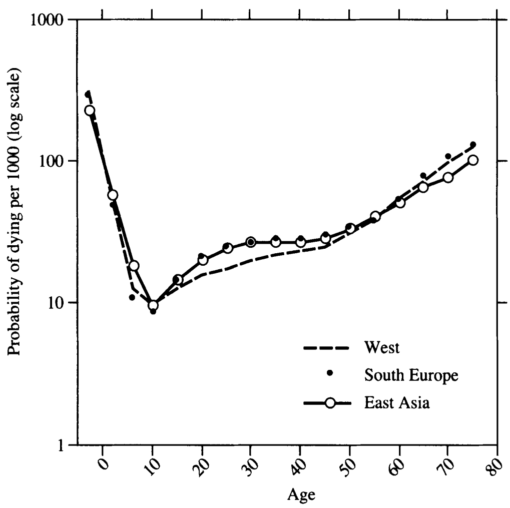

Figure 1. *Model age-specific mortality patterns where life expectancy at birth is 25 years*
Note: $q(x)$ is shown for $e(0)$ at 25 years.

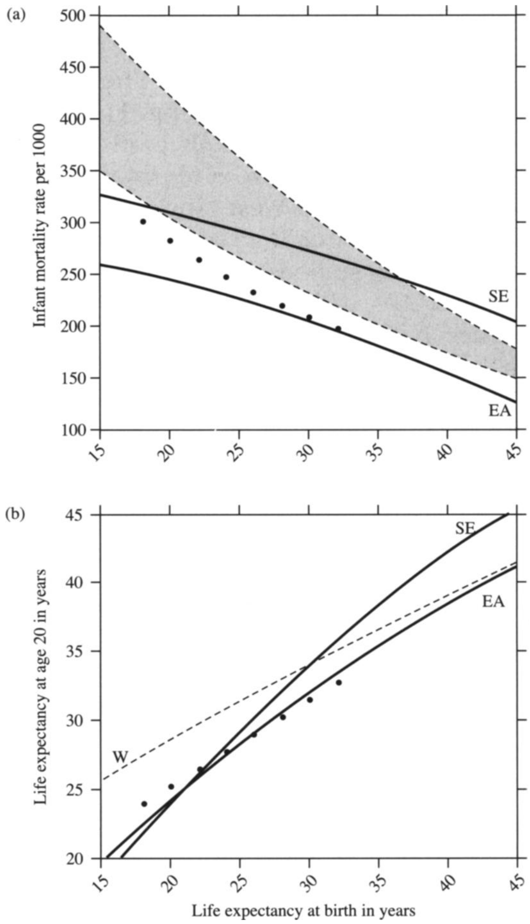

Figure 2. *Mortality patterns in model life tables*

Notes: See text for explanation.
W Princeton Model West
SE South Europe Model, tab. 2
EA East Asia Model, tab. 3
• Preston, McDaniel, and Grushka, 'New model life tables'.

system as life expectancy at birth rises. The top edge is formed by Model South while the bottom edge is Model East. This means that in a population where $e(0)$ is believed to be 25, the infant mortality rate could vary between 250 and at least 350. Also according to the Princeton models, if the infant mortality rate was thought to be 300 then $e(0)$ could lie between 20 and 30 years depending on which of the four 'families' of model life tables was selected. The South Europe and East Asia models have infant mortality increasing at a slower rate than the Princeton models as life expectancy declines. In the case of South Europe, there is an area of overlap with the Princeton patterns, but the East Asia models operate at an even lower level of infant mortality. The 'New model life tables' developed by Preston et al. track the lower edge of the scimitar shape and fit neatly between South Europe and East Asia. The mortality patterns illustrated by figure 2(b) are rather less interesting. Here the Princeton system is represented by Model West. At very high levels of overall mortality, the South Europe, East Asia, and Preston et al. models all show even higher levels of adult mortality than the West. Indeed, the last two mentioned coincide rather well. The rate of change of adult mortality ($e(20)$) with life expectancy at birth ($e(0)$) is steepest for South Europe so that for $e(0)$s greater than 30 years, $e(20)$s will be higher than those from Model West. In broad terms, figure 2 illustrates the point that at very high levels of mortality deaths at early ages will be fewer and at adult ages greater than the Princeton models would lead us to expect. We shall return to this point in the next section.

One of the benefits of selecting standards from the *Causes of death* collection is that it allows us to explore the possible cause of death structures of two high-mortality populations in more detail. Table 4 summarizes the patterns described by the statistics available for Chile and Taiwan in the early twentieth century. It has been constructed so that there are in each

Table 4. *Cause of death patterns for standard populations: South Europe (SE) and East Asia (EA)*

	0	*1–4*	*5–14*	*15–49*	*50+*	*Total*
South Europe (SE)						
All causes	3,020	1,259	472	2,439	2,810	10,000
(1) Respiratory TB	295	169	70	286	166	986
(2) Other infectious & parasitic	392	166	55	241	237	1,091
(3) Neoplasms	76	44	19	122	107	368
(4) Cardiovascular	419	193	78	462	537	1,689
(5) Influenza, pneumonia, bronchitis	631	283	104	532	562	2,112
(6) Diarrhoea	148	47	15	85	101	396
(7) Certain degenerative	32	18	8	44	34	136
(8) Violence	43	22	7	29	28	129
(9) Other causes	984	317	116	638	1,038	3,093
East Asia (EA)						
All causes	2,096	1,520	690	2,943	2,751	10,000
(1) Respiratory TB	101	92	53	252	171	669
(2) Other infectious & parasitic	284	185	74	272	169	984
(3) Neoplasms	17	15	8	46	41	127
(4) Cardiovascular	44	39	21	103	128	335
(5) Influenza, pneumonia, bronchitis	675	516	222	819	483	2,715
(6) Diarrhoea	99	74	27	121	117	438
(7) Certain degenerative	70	63	31	143	134	441
(8) Violence	32	29	14	40	24	139
(9) Other causes	774	507	240	1,147	1,484	4,152

Note: See text for explanation. The nosology from which this table is developed is described in detail in Preston, Keyfitz, and Schoen, *Causes of death*, pp. 4–7 and 30–42. The table is indicative only.
Sources: Derived from data for Chile 1909 and 1920 for females (SE), and Taiwan 1920 for females (EA) in Preston, Keyfitz, and Schoen, *Causes of death*, pp. 147, 151, and 703.

case a total of 10,000 deaths; just as in tables 2 and 3 there were the same numbers of life table births and deaths. These 10,000 are distributed among five age groups and nine cause-of-death categories. The age groups have been defined so that they reflect the principal life stages in terms of the age-specific mortality curve (figure 1): infancy, childhood, youth, adulthood, and old age. The cause-of-death categories are essentially those used in *Causes of death*, although maternal deaths and certain accidents have been included in (9) Other causes. This has been done so that the cause-of-death profile for females can be used to describe the general characteristics of the total population more easily.[23] It must be emphasized that nosologies for historical populations are fraught with difficulties.[24] All that can be expected of table 4 is that it will offer an indication of how certain major causes of death affected particular age groups, which were especially influential in determining low levels of life expectancy ($e(0)$ less than 30 years), and that the structure of cause of death patterns varied between disease environments.

Table 4 helps to underline the importance of childhood mortality. Between 36 and 43 per cent of all deaths are likely to fall in the 0–4 age group, which includes infants and young children. Here the dominant causes are infectious diseases of various forms, but especially (5) Influenza, pneumonia, bronchitis, and (2) Other infectious and parasitic diseases. In combination, these categories make-up 34 and 46 per cent of deaths in the first two age groups. Tuberculosis (1) is also important, but less so than among the adults (15–49). There are many similarities between the two cause-of-death patterns, as well as a few inexplicable differences. For example, category (4), Cardiovascular diseases, is far more important in the South Europe (Chile standard) population than in East Asia (Taiwan). One of the areas of similarity is the dominance of (9) Other causes. This residual, catch-all category is comprised of poorly specified and ill-defined causes, many of which will doubtless have been infectious in nature.

How do these patterns compare with what is believed to have applied in ancient Greece and Rome? Certain diseases, especially those with obvious external symptoms, are known to have been important; they are mentioned in contemporary medical and literary accounts. Of the water- and food-borne diseases, typhoid, cholera, diarrhoea, and dysentery were certainly significant, while pneumonia and tuberculosis appear to have been identified

[23] It seems more reasonable to continue to use data for females, as was done with the construction of the standard life tables, than to attempt a combination of female and male cause of death data. Accidents among young adult males tend to distort their mortality pattern. For Chile, maternal deaths contributed 158 and for Taiwan 140 to the 10,000. Preston, Keyfitz, and Schoen, *Causes of death*, p. 3, calculate that for their six populations with female $e(0)$s less than 40, maternal deaths represented 1.62% on average.

[24] See Woods and Shelton, *Atlas of Victorian mortality*, for an analysis of cause of death by age by location for nineteenth-century England and Wales. Even here there are major problems in the interpretation of such data.

as other infectious diseases. Malaria was important in many parts of the Mediterranean world, while bubonic plague, measles, and smallpox were damaging from time to time.[25] Frier has also observed that 'The major causes of death probably did not differ much from those prevailing in early modern Europe'.[26]

In recent years there has been a debate over the existence of distinctive regional, even local, mortality patterns in the past. At the regional level this has focused especially on the Far Eastern pattern, which is said to display higher than expected mortality rates among older adult males and a substantial gender differential in general. It has also been speculated that tuberculosis may have had an important bearing on this distinctive mortality profile.[27] While there is some doubt about whether the Far Eastern pattern was unique and even if it was, for how long it prevailed, as well as its geographical extent, it is impossible to avoid the conclusion that before the twentieth century certain regions were likely to have experienced highly distinctive cause-of-death patterns that were environmentally and epidemiologically determined. The prominence of tuberculosis in East Asia is just one example and that of malaria in parts of Greece, Italy, and Roman Egypt is another. These observations have led to interesting speculations regarding the variability of mortality patterns and the degree to which model life tables are capable of capturing such demographic diversity at the local level. Sallares, in particular, has argued that as far as the 'reality of Roman Italy' was concerned, 'There were some extremely unhealthy localities, with a life expectancy at birth hovering around 20, in some cases no more than a few kilometres away from other

[25] While most authorities agree on the list of important diseases, there is little scope for quantitative analysis of their impact. See, for example, Grmek, *Disease*; Sallares, *Ecology*, pp. 221–93; Scobie, 'Slums', p. 421; Duncan-Jones, 'Impact of the Antonine plague', p. 116, n. 88; Scheidel, 'Demographic and economic change'; Shaw, 'Seasons of death', p. 133; and Scheidel, 'Measuring sex, age and death', pp. 147–55. Scheidel, *Death on the Nile*, on Roman Egypt; and Shaw, 'Seasons of death', on Rome, are the most comprehensive accounts because of their analysis of seasonal mortality patterns, but they are obliged to exclude infants and children (0 and 1–4 in table 4) and to 'borrow' from the better documented experiences of nineteenth- and early twentieth-century Egypt and Italy, respectively. Brunt, *Italian manpower*, pp. 611–24, and Sallares, *Malaria*, are most helpful on malaria and its debilitating effects. Herlihy, *Pisa*, especially pp. 35–53, illustrates the significance of malaria in the decline of Pisa and Lucca during the late thirteenth century. Scheidel and Sallares make a very convincing case for taking an ecological approach to epidemiology and thus demography, an approach that has been the stock-in-trade among medical geographers for many years.

[26] Frier, 'Demography', p. 792. Frier gives four reasons why Roman mortality stayed so high: poor nutrition, poor sanitation, urban networks facilitated the spread of disease, and under-bureaucratization prevented the development of public health measures (ibid., p. 793). The idea that Rome, in particular, and large cities, in general, acted as huge demographic sinks has also been taken up in, for example, Scheidel, 'Germs'; Sallares, *Malaria*; and Scheidel, 'Human mobility I' and 'Human mobility II'; and is represented in the contributions to Hope and Marshall, eds., *Death and disease*.

[27] Goldman, 'Far Eastern patterns', p. 17. See also Zhao, 'Far Eastern pattern', especially pp. 144–6, where he argues that even the Barclay et al., 'Reassessment', for traditional rural China does not match the so-called East Asian model sufficiently closely. United Nations, *Model life tables*, also develops Far Eastern and South Asian patterns that are used in tab. 1.

localities, where life expectancy at birth may have been as high as 40 or 50'.[28]

II

Two related matters will be considered in this section. The first is technical and demographic; the second more sociological in that it concerns the cultural values, attitudes, and practices surrounding the relationship between parents and their children. Perhaps the most striking point to emerge from the discussion in section I is the fact that populations with $e(0)$s of less than 30 years must experience very high rates of early-age mortality; at least 20 per cent of live born infants will die before reaching their first birthday (figure 2(a)). But it is also the case that mortality in infancy and childhood are the least well understood and that their levels are often judged on the basis of adult mortality estimates. For example, while Frier's life table for the Roman empire is empirically based above age 15, $q(0–14)$ has been introduced from Princeton Model West level 2 since 'very little is known about the exact patterns of juvenile mortality in anthropological societies, and the portion of my Life Table from ages 0 to 10 is therefore plainly the weakest portion of it'.[29] This is exactly the problem faced in studies of historical mortality patterns in East Asia. In China family genealogies offer one of the few opportunities to construct life tables for periods before the twentieth century, and in Japan, while there are some excellent village-based sources from the late seventeenth and eighteenth centuries, certain conventions relating to the recording of ages make it difficult to measure infant mortality directly. In early modern Europe the problem is reversed. There the availability of ecclesiastical parish registers and the development of family reconstitution make it possible to say far more about infant than adult mortality.[30]

Duncan-Jones's study 'Roman life-expectancy' and Scheidel's 'Emperors, aristocrats, and the grim reaper' illustrate the importance of these

[28] Jones, *Malaria*, as long ago as 1909 argued the case for malaria having had a destructive effect on Greek demography, economy, and society. His case is reinforced by Sallares, *Malaria*, p. 283. Sallares (p. 160) and Scheidel, *Death on the Nile*, p. 132, both make heavy use of a study on the Tuscan village of Grosseto in the 1840s by Del Panta, *Malaria*, pp. 22–3. The village had an $e(0)$ of 20 years and was much afflicted by malaria. 'In plain language, conditions in Grosseto were so bad that adult mortality went right off the bottom end of the scale generally used by demographers', by which Sallares means that its $q(20–49)$ of 600 per 1,000 was not matched by any of the Princeton models, 'even the "worst" model life-tables used by demographers'. Sallares and Scheidel turn this into a criticism of standard models *per se*. In the South Europe model (tab. 2) $q(20–49)$ is 633 when $e(0)$ is 20.

[29] Frier, 'Ulpian's evidence', p. 246. Frier's, 'Pannonian evidence', which is based on skeletal data, has the same problem. Scheidel, 'Roman age structure', p. 7, makes the point clear: 'there is no usable evidence for childhood mortality from classical antiquity'. See also Scheidel, 'Progress', p. 23; and Scheidel, *Death on the Nile*, pp. 31 and 34.

[30] The following provide examples: for China, Zhao, 'Long-term mortality', and Lee and Wang, *One quarter*, pp. 42–62; for Japan, Smith, *Nakahara*, pp. 47–58; and for England, Wrigley, Davies, Oeppen, and Schofield, *English population*, pp. 198–353. Bideau, Desjardins, and Brignoli, eds., *Infant and child mortality*, surveys the field, but does not tackle the ancient world.

problems.[31] Duncan-Jones has used the list of members of the town council of Canusium, a small town in southern Italy, for the year 223 AD to derive an estimate of adult male mortality. He finds an $e(25)$ of 34 by one approach and 32 years by another (equivalent to $e(20)$s of 37 and 35), and suggests that the pattern of mortality is best represented by Princeton Model South level 6, which would give an $e(0)$ in the low thirties (31.7 years, perhaps). These estimates for a particular social group are then compared with Ulpian's evidence and Frier's use of that evidence. Duncan-Jones suggests that $e(20)$ should be 29.5 (by interpolation) or 28.17 years (by Frier's approximation), and that if these two measures of general adult mortality are matched with Princeton Model South they yield $e(0)$s 'well below 20 years'. One of the possible implications of this contrast is that the estimates merely reflect social differences in Roman society: for the upper classes an $e(0)$ of 32 might be possible, but for the servile classes (especially slaves and ex-slaves) one of 20 years or less is more likely. Of course Duncan-Jones is aware of other possibilities, including the reliability of the model life tables. The patterns shown in figure 2(b) suggest an alternative conclusion. For an $e(20)$ of 36 years the South Europe model also suggests an $e(0)$ of 32 years, but for one of 29 then $e(0)$ would be about 24 years.[32] Among 30 Roman emperors the mean age at accession was 41.13 while the average number of subsequent years lived was 19.27. By Princeton Model West level 4 this would imply an $e(0)$ of 26.3 years, while by South Europe a lower life expectancy at birth of 23–4 years would be indicated. Scheidel also notes that similar levels of mortality seem to have prevailed among Roman senators, with Princeton Model West level 5 offering a convincing fit. This encourages the general observation that whilst there certainly were marked social divisions within Roman society, they were not strongly reflected by marked differences in life chances and that, more specifically, the new model life table proposed here in table 2 would make any class differentials based on adult mortality seem even narrower.[33]

Figure 2(b) is also useful in distinguishing the plausible from the rather unlikely. Russell has given many examples of mortality estimates for ancient Rome and medieval Europe. For the Roman empire his $e(20)$s range from 19 to 29 years depending on period, place, and gender, but 22–5 is an average level.[34] This corresponds with an $e(0)$ of around 20 or less in the South Europe model. Russell's other approximations of $e(20)$ include the following: 26.9 years for Pisa in 1427; 23.9 for non-plague periods of the Middle Ages; and 19.8 for England, 1348–1500.[35] Figure 2(b) indicates that while the life expectancy for Pisa might be pos-

[31] Duncan-Jones, *Structure and scale*, pp. 93–104; and Scheidel, 'Emperors'.

[32] See also Parkin, *Demography*, pp. 137–8.

[33] Scheidel, 'Emperors', p. 280, develops the general point at greater length while also raising the additional consideration that ancient elites tended to live in high mortality urban environments.

[34] Russell, *Ancient and medieval*, p. 168, tab. 44.

[35] Ibid., pp. 46, 51, 137.

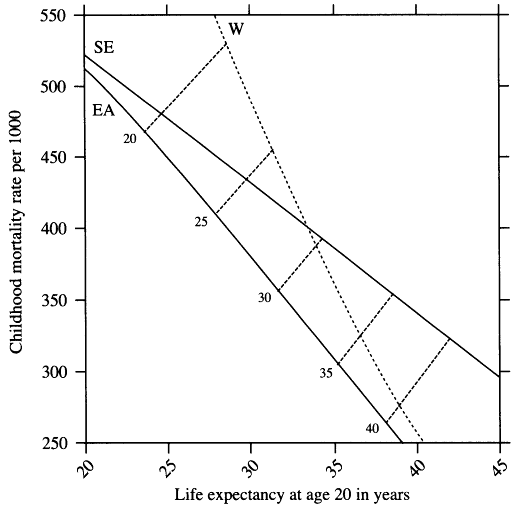

Figure 3. *The relationship between childhood (q(0–4)) and adult mortality (e(20)) among the model life tables*
Notes: See text for explanation.
W Princeton Model West
SE South Europe, tab. 2
EA East Asia, tab. 3
20, 25, . . . , 40 refer to approximate *e*(0)s.

sible, *e*(20)s substantially less than 25 years are likely to imply unrealistically high levels of mortality for populations that were replacing themselves, and growing, albeit slowly.

However, whilst it is useful to derive overall mortality from adult mortality (*e*(0) from *e*(20)), it would also be helpful to judge the level of risk experienced during childhood from that faced in adulthood. Figure 3 uses Princeton Model West, the South Europe, and East Asia models to illustrate what might be expected of the childhood mortality rate (*q*(0–4) per 1,000) given different levels of adult mortality (*e*(20)).[36] Infant and early childhood mortality have been combined to avoid the problem that sometimes occurs where the latter appears to be greater than the former. Although this may be a true reflection of epidemiological circumstances, it can also mean that the infant mortality rate has been underestimated because infant deaths have been missed, or concealed. Let us return to Frier's life table for the Roman empire in which *e*(20) was 28.4 years.[37] The South Europe model gives a childhood mortality rate of around 440, which, although high, is substantially less than the 510 proposed by Frier.

The East Asia model can be used in a similar way. Estimates of *e*(20) for early modern China suggest a range of 29–41, with an average for males at

[36] Woods, 'Historical relationship', discusses these issues at greater length.
[37] Frier, 'Ulpian's evidence', p. 245, tab. 5.

about 34 years.[38] This would indicate a childhood mortality rate of 310 and an $e(0)$ around 35. But these $e(20)$ estimates come mainly from clan genealogies for the early Qing; ages at death may have been exaggerated, and this period of the eighteenth century was relatively free of wars and crises. Other, more recent and perhaps more securely based estimates offer examples of $e(20)$s closer to 30 (e.g. Beijing in the early Qing) while confirming that in some periods and places figures in the mid-thirties are justified.[39] The East Asia model shows that if $e(20)$ is 30 years then childhood mortality will be around 380 and life expectancy at birth will be in the high twenties. In one of those rare cases in which early-age mortality can be derived directly from the genealogical evidence it was found that childhood mortality for the Qing imperial lineage in Beijing was about 290 ($q(0–4)$ per 1,000).[40] The Japanese village studies that use data from the Tokugawa period indicate that $e(20)$ for males and females combined averaged about 40 years, although there are examples from the low thirties.[41] This suggests a remarkably low level of adult mortality; implausibly low when compared with the East Asia model. According to figure 3, childhood mortality would need to have been less than 250 and $e(0)$ greater than 40 years. One study of a group of villages in Hida province for the period 1776–1855 reports the following estimates: $e(20)$ is 41 years, $q(0–4)$ is 450, and $e(0)$ is 33.[42] For another group of villages in Mino province (1751–1869) the equivalent estimates are 40 years, 310, and 38 years.[43] Both the Hida and Mino studies use either Princeton Model North or West to derive their infant mortality estimates and thus to establish $e(0)$. With the aid of the East Asia model, our 'best guess' would be that late Tokugawa Japan (roughly 1750–1850) had a mortality pattern in which $e(20)$ was in the mid- to upper-thirties, childhood mortality ($q(0–4)$ per 1,000) was around 300, and life expectancy at birth ($e(0)$) was about 35 years.[44] If childhood mortality were to increase for any reason (to 350 perhaps), then life expectancy at birth would be pushed into the low thirties. In each of these cases, the model mortality pattern selected is all-important.

[38] See Woods, 'Historical relationship', p. 208, tab. 3. Zhao, 'Long-term mortality', suggests that the mortality experienced by members of the Wang clan remained relatively stable over several centuries and that it may be represented by Princeton Model East level 8 ($e(0)$ is 34.77 years and $q(0–4)$ is 372 for males). However, other evidence from clan genealogies indicates lower levels of life expectancy and this is reinforced by comparison with the East Asia model in tab. 3.

[39] Lee and Wang, *One quarter*, pp. 54–5, tabs. 4.1 and 4.2.

[40] Lee, Wang, and Campbell, 'Infant and child mortality', p. 404, tab. 2. The combined male and female estimates for $q(0–4)$ varied from 366 in the early eighteenth century to 238 in 1821–40. This would be consistent with $e(0)$s in the low thirties.

[41] Woods, 'Historical relationship', p. 210, tab. 4.

[42] Jannetta and Preston, 'Two centuries', derived from the app. tab. on pp. 433–4 for males and females combined.

[43] Saito, 'Infant mortality', derived from data in tab. 8.4, fig. 8.4, and note 1.

[44] This is broadly consistent with Saito, 'Infant mortality', but it suggests that Jannetta and Preston, 'Two centuries', have over-estimated the level of infant and child mortality because $e(20)$ has been exaggerated and they favour an $e(0)$ in the low thirties.

These observations bring us to the problem of parent–child relations, how adults cared for their offspring, whether feelings were conditioned by demographic experience, and how attitudes to offspring influenced adult behaviour.[45] The practice of contraception, abortion, infanticide, or deliberate neglect, together with the exposure or abandonment, the sale, or putting-up for adoption of children all had a bearing on early-age survival chances. But to what extent were parents indifferent to their children, and was this an effect or a cause of high mortality? While there is some degree of consensus on the existence of these practices in ancient Greece and Rome, Qing China, and Tokugawa Japan, scholars continue to debate their extent and what demographic impact they had.[46] If it could be demonstrated unequivocally that childhood mortality was closer to 350 than 450, for example, it would make the possibility of extensive infanticide appear less likely. Although this cannot be done as yet, the South Europe and East Asia models assist in the general down-scaling of early-age mortality levels in low-life expectancy, historical societies. Infant and early childhood mortality were certainly high by modern standards, but although they are not so excessive as to make one wonder how replacement was possible, they do oblige one to consider how parents were able to cope emotionally with repeated losses.

Sir Moses Finley once reflected on responses to death in the ancient world.

> The ancients did not draw up demographic tables, graphs, and curves, but they would have been fully aware of their high infant mortality and the considerable chance of death at any age, spasmodically increased by epidemics and wars. Unlike us, they had no experience or knowledge of qualitatively different demographic patterns against which to measure and judge their own: . . . Therefore their expectations were equally constant. I do not refer particularly to the personal expectation of imminent death, as I see no reason to think that in this respect their psychology was radically different from our own.[47]

[45] Shaw, 'Cultural meaning', and, more recently, Parkin, *Old age*, provide valuable discussions of attitudes towards death in ancient Rome.

[46] See, for example, Harris, 'Theoretical possibility', p. 115 (10% infanticide possible); Patterson, 'Not worth the rearing'; Engels, 'Use of historical demography', p. 393 (no evidence for infanticide in Roman Egypt, and a 10% rate among healthy children 'cannot be demonstrated'); Golden, 'Demography and the exposure of girls'; Hopkins, 'Contraception', p. 127 (contraception confused with abortion, effective methods for both were known, but extent of practice uncertain); Hopkins, 'Brother-sister marriage', p. 317 (for Roman Egypt, no evidence that female infanticide was practiced on a large scale); Scheidel, 'Progress', pp. 44–5; Lavely and Wong, 'Revising the Malthusian narrative', p. 734–8 (considerable potential impact of female infanticide of 10–20% in late imperial China); Lee and Wang, 'Malthusian models', p. 40 (female infanticide 'average perhaps' 10% nationally in the eighteenth century, but up to 40% at times among the Qing nobility); Cornell, 'Infanticide', p. 45 (infanticide negligible among healthy infants in Tokugawa Japan); Saito, 'Infanticide', p. 375 (little doubt that infanticide and abortion were practised by some groups in some areas at some times, but this was not done on a scale that was sufficiently extensive and systematic to account for the low levels of recorded marital fertility).

[47] Finley, 'Elderly in classical antiquity', p. 158.

And on the deaths of children and spouses, Finley made several other perceptive remarks that are also worth quoting at length.

> Any Greek or Roman who reached the age of marriage could look forward to burying one or more children, often very small ones, and to burying a young wife or rather less young husband and to remarrying with the same unhappy prospects. I do not suggest that Greeks and Romans buried their children and spouses without a sense of loss; . . . What I do suggest is that in a world in which such early deaths and burials were routine, so to speak, the intensity and duration of the emotional responses were unlike modern reactions, though I confess that I know no way to measure or even to identify the differences.[48]

Finley has not gone unchallenged, however. For example, he has been accused of demographic determinism, of accepting that 'demography largely governs emotional responses'.[49] This charge is made under the assumption that in Greek and Roman society the infant mortality rate ($q(0)$ per 1,000) was 300–400, implying that at least half of those born alive would not survive to marriageable ages.[50] But Finley is more subtle in his thinking, as well as being more demographically imprecise. He is aware of the infanticide or exposure problem. There may have been an intense emotional attachment between parents and children, but it would only apply to those foetuses allowed to go to full-term and those infants selected for survival.[51] The untimely death of a chosen one could certainly engender feelings of parental grief and a period, perhaps short, of family mourning. Indeed, at least some children were commemorated by tombstone inscriptions as well as inspiring literary memorials.[52] Finley also links the deaths of children and spouses. This is especially important in those high-mortality societies in which marriage for one or both partners was at an early age. Hopkins has estimated that the median age at marriage for Roman females fell in the range 15–16 years and that for males it was 24–6.[53] He also

[48] Ibid., p. 159.

[49] Golden, 'Did the ancients care', p. 154; and *Children*, p. 82. Golden also commends Hopkins, *Death and renewal*, p. 225, among others, for not jumping to deterministic conclusions as far as the ancient world is concerned.

[50] Néraudau, *Être enfant*, says that infant mortality is impossible to estimate, but he quotes a $q(0\text{–}9)$ of 323. He also discusses Roman attitudes to infant deaths using both literary and tombstone evidence (pp. 373–92). This theme is taken up to even greater effect in Huskinson, *Roman children's sarcophagi*. The most recent survey of the literature by Rawson, *Children*, p. 104, favours a $q(0)$ of 300, citing Hopkins, *Death and renewal*, p. 225, and Parkin, *Demography*, pp. 92–4, as her sources. Scheidel, 'Human mobility I', assumes that 'half of all newborns would die before reaching full sexual maturity', p. 17.

[51] Soranus, the influential obstetrician who worked in Rome during the early second century AD, offered detailed guidance to midwives on 'How to recognize the newborn that are worth rearing'. See Temkin, ed., *Soranus*' Gynecology, pp. 79–80.

[52] Certainly, infants and children were under-represented in inscriptions, but they were not totally absent. See Rawson, *Children*, as well as Saller and Shaw, 'Tombstones', and Shaw, 'Latin funerary epigraphy'. The literary evidence from epitaphs is surveyed by Lattimore, *Themes*, especially pp. 143, 172–8, 215–16; and Oliver, ed., *Epigraphy*, while Sourvinou-Inwood, '*Reading*', and Golden, 'Change or continuity?', consider aspects of the changing vocabulary used in relation to death in ancient Greek. Garnsey, 'Child rearing', pp. 64–5, is sceptical about indifference, preferring to emphasize the cultural norms of a pre-scientific society.

[53] Hopkins, 'Age at marriage'.

Table 5. *Example childhood mortality rates for early modern Europe*

	q(0–4) per 1,000
England 1550–1649	
Rural, remote	129
Predominantly rural, non-metropolitan	242
Towns	290
London	375
France 1680–1789	
Villages, nurslings excluded	342
Villages	466
Towns	458
Rural 1680–1749	488
Rural 1750–89	427

Source: Based on Woods, *Children remembered*, tabs. 3.1 and 3.2, pp. 40, 46.

suggests that puberty occurred on average around 13+ and that there was a substantial number of examples of very young marriages among girls, leading him to conclude that there will have been cases in which unions with pre-pubertal females were consummated and thus that 'the emotions which Romans invested in marriage must have been quite different from our own'.[54]

In the case of early modern Europe, a period and place for which the parental indifference hypothesis was first proposed, there appears to be an acceptance that parents did in general feel and express grief over the deaths of their offspring.[55] Most women in northern and western Europe did not marry and become mothers until well into their twenties. They were more mature parents than were the mothers of the ancient world, or early modern East Asia, and this might be assumed to have had a bearing on their attitude to childrearing as well as their reproductive capacity. In Europe the experience of early-age mortality was quite diverse. Some remote, rural areas in England are believed to have had infant mortality rates below 100, while in those regions where maternal breastfeeding was not common practice (e.g. southern Germany) or where infants were put out to be breastfed by a wet nurse away from home (e.g. urban France) far higher levels of mortality were faced in equivalent disease environments. Contraception, abortion, infanticide, and exposure were uncommon, although some infants and children, especially those born to unmarried mothers, were abandoned to the care of foundling hospitals, where they faced considerably higher risks of early death. Table 5 uses childhood mortality rates for England and France from the sixteenth to eighteenth centuries to illustrate some of these points. Above all, it reminds us of the diversity of the mortality experience,

[54] Ibid., p. 310.
[55] Woods, 'Did Montaigne?', and *Children remembered.*

especially at early ages, and encourages the drawing of analogies with the ancient world.[56]

III

We have already seen that historians of ancient Greece and Rome often make comparative references to premodern or early modern societies. They argue that if *X* and *Y* are sufficiently close in terms of their technological development (especially control of diseases) and social organization, it is justified to regard the two demographic regimes as analogous; knowledge of one may reasonably be applied to the other. The assumptions underlying this approach are rarely questioned, yet they are of fundamental importance if 'demographic borrowing' is to be regarded as a legitimate procedure. We shall consider three aspects of the problem here. First, what forces articulate the form and function of a demographic regime? Second, what are the most important features of such regimes? Third, how internally differentiated may a regime become and yet retain sufficient coherence and distinctiveness that it can be recognized as a separate entity?

The convention has been to think in terms of self-equilibrating systems with positive and negative loops articulated, so that demographic experience is maintained in broad conformity to the demands of the economy. The Malthusian demographic system provides the classical illustration. Here population growth is kept in check either by heightened mortality (positive check) or reduced fertility (preventive check). The benefits of controlled growth for the economy and material living conditions in general are considerable, and the danger in terms of recurrent crises (including misery and vice) may prove catastrophic. This approach owes much to population ecology; it emphasizes structure over agency; and is likely to be most effective when applied to those prehistoric societies that had limited ability to manage their environments.[57] It is doubtful whether ancient Greece and Rome should be thought of in such simple terms. Here there was an elaborate social hierarchy with perhaps a third of the population living in slavery, as well as extensive trading and military empires. The resulting demographic regimes were complex, reflecting the demands of cultural

[56] Table 5 reflects the effects of urban–rural differentials as well as different practices of childrearing, especially breastfeeding. Assuming the presence of such variability in Greece and Rome would certainly have an important bearing on studies of mortality patterns in the ancient world, but at the moment more can be said about attitudes to, than the life chances of, children at this time. Certainly, direct evidence is beginning to emerge of variations in adult mortality, but 'demographic borrowing' is required where infants and children are concerned. If, as Sallares, *Malaria*, p. 283, argues life expectancy at birth in the Roman empire varied from 20 to 50 years this could only have been produced by very considerable differentials in early-age mortality.

[57] See Weiss, *Demographic models* and, 'Application of demographic models'; Swedlund, 'Historical demography'; Petersen, 'Demographer's view'; Wood, 'A theory'; and the contributions to Hoppa and Vaupel, eds., *Paleodemography*, for examples. Palaeodemography is often criticized for its over-optimistic and determinist approach; its dependence on models, and reliance on dubiously dated, aged, and sexed skeletal remains.

practices as much as material necessity. It also appears likely that these regimes were conditioned by an especially challenging disease environment, and by the effects of war.[58]

Late and far from universal marriage in combination with the nuclear family have been singled out as the most important characteristics of the demographic regime in early modern Europe. The famous north-west European marriage pattern set Europe and Europeans apart; it contributed to their economic success by ensuring a high degree of demographic stability via the preventive check to fertility. Recent research on the East Asian demographic regime stresses the importance of net reproduction or effective fertility, that is the production and survival to reproductive age of offspring, together with the various factors that influenced both fertility and early-age mortality. It would appear that these elements were also of special significance in ancient Greece and Rome. There, early marriage for females, low marital fertility, and poor infant survival chances were also important characteristics.[59]

Historical demographic regimes were internally differentiated in at least two respects: by wealth and social standing, and in terms of the rural and urban environments. It is usually assumed that there were two mortality gradients, one distinguishing the demographic sinks of cities from the more healthy countryside, and the other dividing the wealthy, who at every age would be expected to face a lower risk of premature death than the poor, who always lived at greater risk of foreshortened lives. On the former, it is tempting to speculate, as several ancient historians have, that in terms of mortality, early modern cities may profitably be compared with republican Rome: that the high-risk urban environment dominated the demographic experiences of the citizens making them comparable despite the intervening 1,500 years.[60] On the latter, it has proved far more difficult to establish the true dimensions of social mortality gradients in the past, but there has been a general agreement that such gradients were less clear-cut and probably narrower than those between rural and urban environments. As far as life-

[58] Wrigley and Schofield, *Population history*, propose 'a dynamic model of the relationship between population and environment in early modern England', pp. 454–84, which is strongly influenced by Malthus's *Essay on the principle of population* (1803). Douglas, 'Population control', suggests an alternative emphasis on cultural values, rituals, and beliefs, rather than subsistence alone, as a way of looking at demographic regimes. Her point has generally been ignored by historical demographers, although 'regimes' are now more popular than 'systems' models. Frier, 'Demography', has described the demographic regime of ancient Rome, as has Scheidel, 'Progress'. The concept of 'demographic regimes' is rarely defined by ancient historians, however. See Woods, *Demography*, tab. 10.1, p. 384, for a list of regime components.

[59] Liu, Lee, Reher, Saito, and Wang, eds., *Asian population history*, surveys some of the recent research. There is a continuing debate on the apparently low level of fertility in China prior to the 1960s. The influence of early marriage, poor nutrition, abortion, infanticide, and contraception are still contested, just as they are for the ancient world. See Campbell, Wang, and Lee, 'Pretransitional fertility'. See Woods, *Demography*, pp. 381–99, for a consideration of effective fertility and its central role in historical demographic regimes.

[60] See Galley, 'Early modern urban demography'; and Woods, 'Urban-rural mortality'. Table 5 gives an example from France of how under certain circumstances rural areas may appear to experience higher early-age mortality than towns.

chances are concerned, and especially those of one's children, it has always been advantageous to be an aristocrat rather than a peasant or a slave, yet differentials in terms of $e(0)$ are unlikely to have exceeded five years before the twentieth century simply because the general level of life expectancy was so low, and the health advantage that could be bought was relatively slight.[61]

Consideration of these three topics—drivers, characteristics, and differentials—challenges simple notions of demographic uniformitarianism. The uniformitarian theory is founded on the assumption that 'The demographically relevant biological processes of our species are constant in our genetic composition, subject only to variation in response to environmental forces, and that the species has not undergone any significant intra-species evolution since its first appearance as *Homo sapiens*'.[62] There are, of course, some constants, such as the maximum length of human life and the normal length of gestation for a foetus, but beyond these examples it is less easy to see how known demographic patterns of the present can be applied to the past in the manner common among palaeodemographers. The demographic borrowing under discussion here may be less systematic, yet it follows a similar principle. The mortality models based on the experiences of other populations from different times hold the key to our understanding. If the South Europe and East Asia models in tables 2 and 3 are believed to offer a superior guide, superior that is to the Princeton models, it looks as though estimates of life expectancy at birth for ancient Greece and Rome may need to be revised upwards somewhat, to the upper twenties or low thirties perhaps. To do this would draw them nearer to the early modern societies of East Asia and Europe, and further away from the hunter-gatherers; closer to history than to anthropology.

IV

Hopkins' 'Graveyards for historians' was negative about the empirical evidence available to ancient historians, but positive concerning the use of models. His general approach to the writing of ancient history was one informed by sociology, by the value of making broad comparisons across time and space, and by using a wide variety of sources in ways that were highly imaginative, deliberately unconventional even.[63] Hopkins was

[61] See Woods and Williams, 'Must the gap widen?', which considers the long-term history of mortality differentials between social groups using mainly European examples and a variety of indices. Clearly some practices heightened the risk of premature death, but the poor level of medical understanding imposed an upper ceiling on life expectancy. Prior to the twentieth century an $e(0)$ of 45–50 was the very best that might be achieved under especially favourable circumstances.

[62] Howell, 'Uniformitarian theory', p. 26.

[63] In terms of social and cultural history, the most important examples are probably Hopkins, *Conquerors and slaves*; 'Brother-sister marriage'; and 'Novel evidence'; but 'Taxes and trade' suggests some original ways of dealing with quantitative economic data, and the contributions to historical demography already mentioned also set new standards. See Harris, 'Hopkins', for other examples and a sympathetic assessment.

probably unwise to place so much faith in the Princeton model life tables, but the originality of his thinking and the breadth of his interests continue to stimulate and challenge. As far as the discussion in this article is concerned, four points need to be emphasized, some positive, others less so.

First, it is clear that the Princeton models have had their day as far as work on populations with $e(0)$s less than 35 years is concerned, but that models of this kind are still invaluable guides and reference points for the plausible.[64] The two models outlined here (tables 2 and 3) add to the stock of possibilities. They suggest that low levels of life expectancy at birth could exist without intolerably high early-age mortality because mortality in early adulthood (15–49) was higher than has previously been expected. They also offer new perspectives on 'unnatural' foetal and infant mortality. More experimentation with these and other low life-expectancy models is required, however.[65]

Second, Hopkins's work on the demography of ancient Rome has illustrated the value of thinking in terms of regimes rather than systems. The same could be said of East Asia and Europe in the early modern period. The demographic regimes concept provides a way of stressing the key distinguishing population structures of a society (e.g. late marriage, high emigration) whilst allowing for some diversity of experience and practice. It is also capable of incorporating the distinctive emphasis advocated by Sallares and Scheidel, that is, one in which ecology, local, and regional variations, and a strong link between disease environment and demography are given pride of place.

Third, the critical importance of infant and childhood mortality has been emphasized once again, along with the role of effective fertility. None of the societies mentioned faced the problem of rapid population growth, as we now understand it. Growth was closer to zero than 1 per cent per year. The challenge was to keep going rather than to rein back. In these circumstances the attitudes of parents to their offspring, the emotional and material attachments, have a special place. If Hopkins is right about the effect of age at marriage on the relationship between Roman spouses, it may well follow that the bond between parents and children was less strong, less emotional, and cooler than contemporary societies claim for themselves. This is still an important area for new research, one in which demographic experience will occupy a central place.

Fourth, the drawing of interesting and suitable analogies was also one of Hopkins's hallmarks. There is a strong temptation to think that all high

[64] Golden, 'Decade of demography', p. 32, calls the model life tables 'illusory', but admits that they are 'good to think with'. Clearly, he misses the point of what models are intended for, and fails to appreciate their flexibility in new, relational forms.

[65] As a final example, let us return to the case of malaria, its indirect influence on other diseases, and its effect via maternal infection on prematurity, low birthweight, and increased late-foetal and neonatal mortality. See Scheidel, *Death on the Nile*, p. 75, on this point, and Woods, 'Measurement of historical trends', on attempts to estimate historical trends in foetal mortality and re-evaluate its importance for mortality patterns in general.

mortality societies may be considered interchangeable. The Yanomama and the Florentines only share a low life expectancy at birth; their environments, material conditions, cultural practices, and so on are entirely different; their demographies do not correspond. But what of the Romans and the Florentines, the villagers of Tokugawa Japan, and the peasants of South China in the 1920s; are these profitable pairings? Our answer is a positive one, as it is hoped Hopkins's would have been.[66]

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[66] It may be recalled that in his second essay of 1803 Malthus juxtaposed a chapter 'On the checks to population in China and Japan' with those on ancient Greece and Rome. For him, partible inheritance, the encouragement to early marriage, the ravages of war and famine, depraved morals, infanticide, and child exposure proved obvious similarities. Hopkins, 'Demography', favours 'facts' over 'impressions', and warns against blurring the 'distinction between the perception of a complex reality, such as the demographic behaviour of the total Italian population, and the reality itself', p. 78. His target is crude demographic borrowing.

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