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LONDON'S MORTALITY IN THE "LONG EIGHTEENTH CENTURY": A FAMILY RECONSTITUTION STUDY

John Landers

"What is now known", Professor Jan De Vries has recently asked, "about the pre-nineteenth century urban population of Europe?"[1] The answer, he concluded, "must be surprisingly little . . . The meagreness of the existing literature is surprising because historians and social scientists have never been hesitant to make sweeping statements about the historical evolution of urban population".[2] These observations hold with particular force in the case of London over what can conveniently be termed the "long eighteenth century" (*c*. 1675–1825), the years falling roughly between the disappearance of bubonic plague and the eve of civil registration.

Over this period, London exhibited the characteristic demographic features of an early modern metropolitan centre in a peculiarly dramatic form. It was very large, containing an estimated ten per cent of England's population for most of the period, and its population managed to grow at a rate approximately equal to that of the country as a whole.[3] Yet for nearly all this time the London Bills of Mortality recorded annual burial totals appreciably in excess of those for baptisms (see figure 1) and at times this shortfall was substantial. In the first half of the eighteenth century, over 400,000 more burials than baptisms were recorded and only in the 1790s did years occur with a surplus of recorded baptisms.

Sustained growth in the presence of such a burial surplus was only made possible by a substantial volume of immigration. The demographic, economic and social

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[1] J. De Vries, *European urbanization 1500–1800*, Cambridge, Mass., and London, Harvard University Press, 1984, 17.

[2] Ibid.

[3] E. A.Wrigley, 'A simple model of London's importance in changing English society and economy 1650–1750', *Past and Present*, 1967, **37**: 44–70; R. A. P. Finlay and B. Shearer, 'Population growth and suburban expansion', in A. L. Beier and R. A. P. Finlay (eds), *London 1500–1700: the making of the metropolis*, London, Longman, 1986, 37–59.

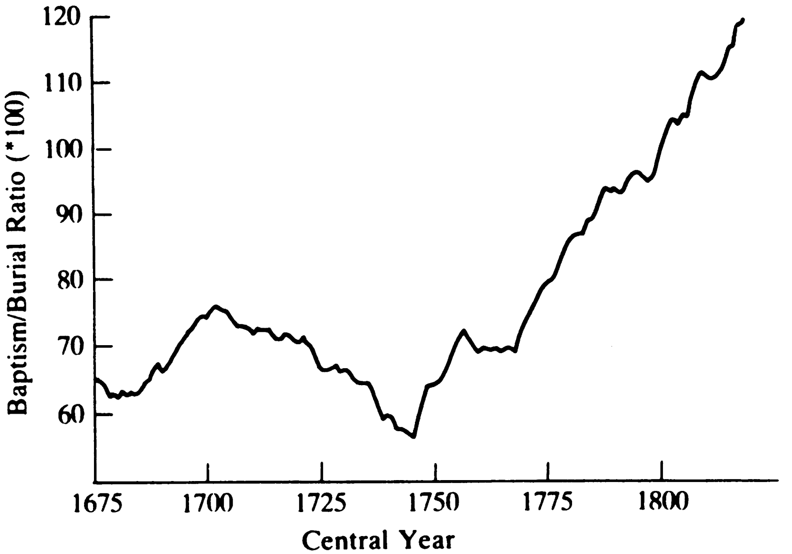


Figure 1. Baptism/burial ratio in London Bills of Mortality (11 point moving average) (*Source:* J. Marshall, *The mortality of the metropolis*, London, 1832.)

implications of this phenomenon have received considerable attention from scholars,[4] but its demographic roots remain to be fully elucidated, and adequate explanations are available neither for the lengthy persistence of the regime of natural decrease, nor for its abrupt transformation at the end of the eighteenth century. In particular, it has not until recently been possible to determine with certainty whether this regime had its basis, as has generally been supposed, in levels of mortality which were substantially in excess of those prevailing elsewhere, or in a lower birth rate, itself in part a product of immigration.[5] One major reason for the relative neglect of metropolitan populations in historical demographic research is, paradoxically, the discipline's growing technical sophistication. As De Vries points out, the new research methods "by attracting the attention of scholars to the rural settings where they are most readily applicable, may be said to have retarded research into urban populations".[6] The most rigorous of these new techniques, and the one which has proved of greatest value in the study of local population history, is that of family reconstitution.

[4] See, for instance, W. H. McNeill, 'Migration patterns and infections in traditional societies', in E. F. Stanley and R. A. Joske (eds), *Changing disease patterns and human behaviour*, London, 1980, 27–36; and, for the specific case of London, Wrigley, op. cit., note 3 above. Wrigley's conclusions are questioned by M. J. Daunton, 'Towns and economic growth in eighteenth-century England', in P. Abrams and E. A. Wrigley (eds), *Towns and societies*, Cambridge University Press, 1978, 245–78. For arguments in support of Wrigley, however, see J. A. Chartres, 'Food consumption and internal trade', in Beier and Finlay (eds), op. cit., note 3 above, 168–96; and B. Dietz, 'Overseas trade and metropolitan growth', ibid., 115–40.

[5] For a statement of the classic "high mortality" position see Wrigley, op. cit., note 3 above. The "low fertility" argument was advanced by A. Sharlin in 'Natural decrease in early modern cities: a reconsideration', *Past and Present*, 1978, **79**: 126–38. Sharlin's view is contested by R. A. P. Finlay, and defended by its author in 'Debate: natural decrease in early modern cities', ibid., 1981, **99**: 168–80. The debate is reviewed in De Vries, op. cit., note 1 above, ch.9; and some broader implications considered by J. M. Landers, 'Mortality and metropolis: the case of London 1675–1825', *Population Studies*, 1987, **41**: 59–76.

[6] De Vries, op. cit., note 1 above, 17–18.

This method, which is based on the nominal linkage of entries from vital registers, is extremely powerful since it is capable of furnishing the researcher with age-specific schedules of vital rates and of performing a limited range of internal checks on the accuracy and consistency of the source materials on which such rates are based.[7] Such advantages, however, are purchased at a substantial price, for the method is laborious and makes considerable demands on the quality of the vital registers, which must be sufficiently detailed to permit the reliable identification of individuals over lengthy periods. Furthermore, the method restricts attention to a limited, geographically stable, "reconstitutable fraction" of the population and yields no information on the size or structure of the population at large or on crude demographic rates. These limitations are particularly relevant to the study of metropolitan populations and, whilst some parish registers from seventeenth-century London have been subjected to a modified form of reconstitution,[8] it has been widely assumed that those for the following century suffered too much from the effects of popular anti-clericalism, clerical laxity, and the growth of religious nonconformity to be suitable for this purpose. The present study attempts to overcome some of these difficulties by using as source material not parish registers as such, but an analogous body of material maintained by two of London's six "Monthly Meetings" of Quakers.

I

The maintenance of vital registers was a central part of the Quaker religious practice or "discipline" throughout the period with which we are concerned, associated as it was with their rejection of the Established Church and its parochial institutions.[9] Quakers were strictly endogamous throughout our period and their meetings conducted marriages, whose validity was recognized in law,[10] buried their dead in Quaker burial grounds, and maintained a sophisticated system of poor relief. The vital registers grew out of this system and differ from Anglican parochial materials chiefly in their registration of births rather than baptisms.[11]

The quality of the vital registers maintained by the London meetings was generally high, the birth registers providing information on residence and occupation of parents, whilst before *c.* 1800 the burial registers generally specify age and cause of death in addition to occupation and place of residence of the deceased or their parents. The information on age and cause of death was provided by the "searchers", who were responsible for gathering the material which appeared in the Bills of Mortality. Hence the cause-of-death categories in the Quaker registers are the same as those appearing in the Bills of Mortality.

The two meetings selected for analysis, those of Southwark and "Peel", were both suburban. Southwark covered the built-up area south of the river including Rotherhithe and Bermondsey, as well as Southwark itself and the parishes of Lambeth,

[7] E. A Wrigley, 'Family reconstitution', in E. A. Wrigley (ed), *Introduction to English historical demography*, London, 1966, 96–159.

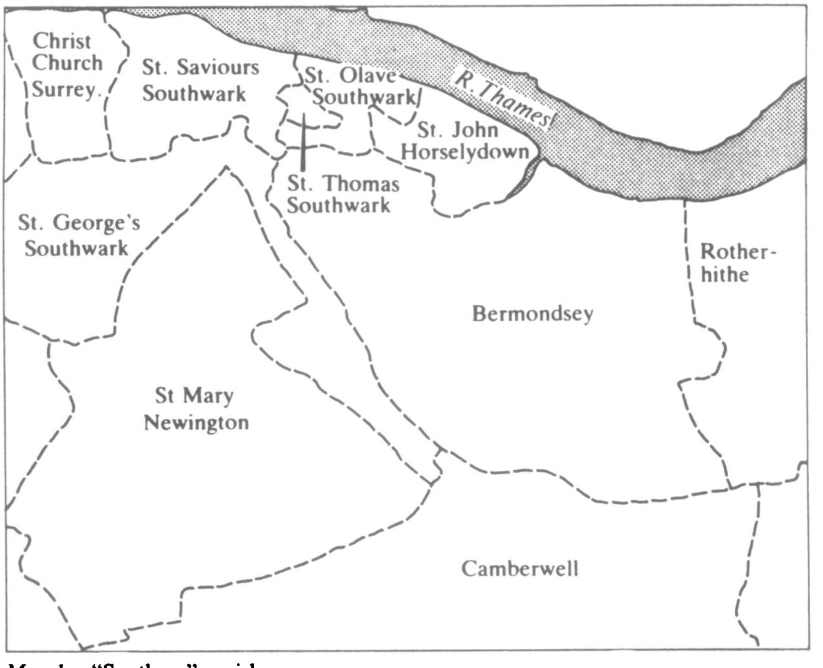
[8] R. A. P. Finlay, *Population and metropolis: the demography of London 1580–1650*, Cambridge University Press, 1981.

[9] A. Lloyd, *Quaker social history 1669–1738*, London, 1950.

[10] Ibid., 51.

[11] J. Rowntree, *The Friends' registers of births, deaths and marriages 1650–1900*, Leominster, 1902.

Camberwell, and Newington Butts, initially rural areas which became urbanized in the last decades of the eighteenth century. Peel meeting covered a less well-defined area taking in the parishes lying in a north-western quadrant outside the city walls (see maps 1 and 2).

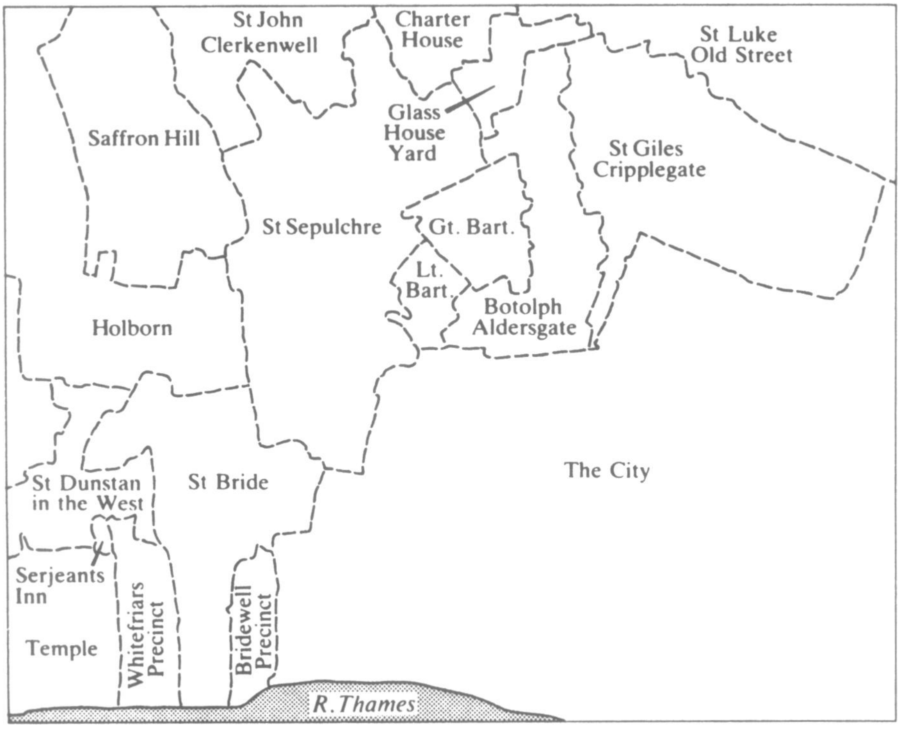


Map 1. "Southern" parishes

The sizes of the meetings are hard to ascertain before the appearance of formal membership lists. Southwark produced the first of these in 1737, including 809 names, and Peel in 1770 with 230. By 1850, these had dwindled to 499 and 178 respectively.[12] Some idea of the size of the study population, relative to that of London Quakers as a whole, can be obtained from the numbers of recorded marriages. Between 1650 and 1749, Peel and Southwark accounted for roughly 19 per cent of the 3,095 marriages recorded in the digests of the London and Middlesex Quarterly Meeting, and in the period 1750–1849 for 24·6 per cent of a total of 1,443 marriages.[13]

A more detailed picture of the geographical structure of the two meetings can be obtained from the residential information contained in the birth and burial registers. This is displayed for the two sources separately (from a 79 per cent sample in the case of the burial registers) in table 1. In both cases the results suggest little change prior to the latter part of the eighteenth century, when a marked shift away from the older "core" areas, towards the newer suburbs such as Islington, Camberwell, and Newington, becomes visible.

[12] J. M. Landers, 'Some problems in the historical demography of London 1675–1825', University of Cambridge, unpublished PhD thesis, 1984, ch.3.
[13] Ibid., 123 n.4.



Map 2. "Northern" parishes

The social composition of the meetings seems, especially during the first century of their existence, to have been heterogeneous. In Southwark, for instance:

> analysis of the subscriptions for the buildings of Horsleydown Meeting-House in 1738 shows it to have had a fair number of prosperous members. Out of the total subscription of £717 9*s*, £642 4*s* was raised by 104 subscribers as follows: sixteen Friends gave amounts varying from £2 to £5; thirty one gave between £5 and £10; six gave £10 10*s* each; thirteen gave £15 15*s*, whilst three gave £20 and one . . . headed the list with £35.[14]

On the other hand, the cost of maintaining numerous poor Friends was a continuous source of complaint on the part of both meetings well into the eighteenth century. Quantitative data are scanty, and the social and economic position of the early Quakers remains a topic of debate.[15] One source of evidence is the occupational information included in the vital registers, but this needs to be interpreted with care, for the same term, for example, "baker", may be used of individuals working in a given trade without regard to their actual role, still less their relative wealth.

The figures in table 2, which are taken from the burial entries with initial letter "B",

[14] W. Beck and T. F. Ball, *The London Friends' meetings*, London, 1869, 226.
[15] B. Reay, 'The social origins of the early Quakers', *J. interdis. Hist.*, 1980, **11**: 55–72.

TABLE 1. DISTRIBUTION OF EVENTS (%) BETWEEN PARISH GROUPS WITHIN NORTHERN AND SOUTHERN AREAS

	Births								*Burials*							
Areas:	Northern				Southern				Northern				Southern			
Groups:	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1650–99	50	15	6	29	27	25	5	43	35	17	16	32	29	19	9	43
1700–49	44	13	17	26	26	27	7	40	31	18	21	30	27	30	13	30
1750–99	31	18	27	24	24	25	22	29	22	14	33	31	21	29	19	32
1800–49	7	11	52	30	11	13	70	6	11	9	49	31	14	14	66	6

Parish Groups

Northern

1. St Botolph Aldersgate, St Bartholomew Great and Less, St Sepulchre
2. St Bride, St Dunstan, Holborn
3. Clerkenwell, Islington
4. St Giles Cripplegate, St Luke

Southern

5. Bermondsey, Rotherhithe
6. Christ Church, Surrey, St Saviour Southwark
7. St George, Southark, Lambeth, Newington Butts, Camberwell
8. SS John, Olave, Thomas, Southwark

Numbers in Sample

	Northern		*Southern*	
	Births	Burials	Births	Burials
1650–99	354	1022	759	1275
1700–49	446	1426	1305	2115
1750–99	361	531	744	840
1800–49	405	288	728	651

TABLE 2. OCCUPATIONAL DESCRIPTIONS IN SAMPLE OF PEEL AND SOUTHWARK BURIAL ENTRIES (%)

	Occupational Categories						
Period	1	2	3	4	5	6	N
1650–99	8·4	5·3	1·0	1·5	74·6	9·2	131
1700–49	21·4	27·2	2·9	7·8	33.5	7·2	206
1750–99	26·2	40·2	3·6	17·3	5·6	7·1	196
1800–49	31·3	35·1	22·3	3·0	2·3	6·0	134

Categories
1. Distributors and distributor-processors
2. Artisans and artisan-retailers
3. Professional and services
4. Transport
5. Servants and Apprentices
6. Others

Source: see text

and classified according to the scheme developed by John Patten,[16] should thus be treated as no more than a broad indicator of trends. Overall the proportion of servants

[16] J. H. C. Patten, 'Urban occupations in pre-industrial England', *Trans. Institute of British Geographers*, new ser. 1977, **2**: 296–313.

and apprentices falls appreciably until 1800,[17] whereas that of "artisans and artisan-retailers" tends to rise. In general, however, there is little evidence of a major discontinuity before the nineteenth century, when the sharp increase in the "professional" group suggests that 1800 marks a watershed in this, as in the geographical, respect.

II

The age-specific mortality rates (technically "mortality probabilities", corresponding to the life table function q_x) derived from the family reconstitution study, are set out in the upper panel of table 3.[18] The overall trend of mortality is similar to that of the vital

TABLE 3. AGE-SPECIFIC MORTALITY RATES (q_x) PER THOUSAND IN 13 ENGLISH PARISHES AND IN PEEL AND SOUTHWARK QUAKER MEETINGS

	London Quakers							
	Months				*Years*			
Cohort	0	0–2	3–5	6–11	0	1	2–4	5–9
1650–74	108	152	51	70	251	103	190	66
1675–99	115	158	46	82	263	113	132	69
1700–24	125	197	59	130	342	145	177	89
1725–49	112	204	58	121	341	143	186	109
1750–74	96	168	82	119	327	150	159	91
1775–99	81	114	38	80	231	101	141	32
1800–24	40	53	41	95	194	93	85	79
1824–49	33	33	37	76	151	77	93	–

Cohort	*Age Group*	*English Parishes*	*London Quakers*
1650–99	0	170	260
	1–4	101	244
	5–9	40	67
	1–9	137	295
	0–9	284	478
1700–49	0	195	342
	1–4	107	298
	5–9	41	95
	1–9	143	365
	0–9	310	582
1750–99	0	165	276
	1–4	103	253
	5–9	33	57
	1–9	133	296
	0–9	277	490

Source: E. A. Wrigley and R. S. Schofield, 'English population history from family reconstitution: summary results 1600–1799', *Population Studies*, 1983, **37**: table 13, p. 177; and reconstitution tabulations

[17] The very high frequency of the terms "servant" and "apprentice" in the seventeenth-century registers probably reflects the relative scarcity of occupational descriptions in the early decades of burial registrations. These two terms seem to have been treated as indicators of household affiliation, on a par with "wife" or "child", rather than as occupational categories, and so individuals in these positions were more likely to be described as such than were heads of households (see Landers, op. cit., note 12 above, 123 n.4).

[18] For convenience, the data have been grouped into fifty-year cohorts, beginning in 1650, with results also being calculated for 25-year cohorts where there are enough observations to make this viable. The numbers

index obtained from the Bills of Mortality. The infant mortality rate for the last cohort is similar to those obtained by the Registrar General of London in the 1840s, which themselves were not much above the national average,[19] but the scale of London's excess mortality before the nineteenth century emerges starkly from a comparison of our results with those obtained from other English reconstitutions, which are set out in the lower panel of the table.[20] This excess is particularly severe in the 1–4 year age group, but it is important to note as well that the trend of mortality in London, at all ages below 10 years, apparently differed from that in the country at large. Infant mortality in the thirteen-parish sample rose a little after 1700, but the childhood rates changed scarcely at all throughout the period. The heightened severity of mortality in early eighteenth-century London thus seems to have arisen from factors specific to the capital, and not as a reflection of deteriorating conditions over a wider area.

In the present paper I shall consider the initial worsening of mortality, and its subsequent amelioration, through a detailed examination of the internal structure of the rates themselves. As a first step, however, it is useful to look at some comparative data from other studies so as to place my own results in an appropriate context. Data of this kind are most widely available for infant mortality, since this is the measure most readily obtained from parish registers, but the infant rate is itself an important indicator of levels of mortality at other ages and so such comparisons can be highly illuminating.

Flinn[21] has tabulated the results of reconstitution studies from a number of regions of early modern Europe, which serve to emphasize the unusual severity of London's mortality throughout much of the eighteenth century. Of the sixteen rates obtained from English studies prior to 1750 none is in excess of 250 per thousand and of eighty French cases for the appropriate period, 20 per cent lie between 250 and 299 per thousand, with only five in excess of 350. Knodel's studies[22] of a number of villages in south-western Germany are alone in reporting levels of this kind on a consistent basis, a finding the author ascribed to the practice of artificial feeding from birth.

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of events recorded for the years before 1675 and after 1824 are, however, relatively small and the effective boundary dates for the study are 1665 and 1840. The infant rates for the cohorts 1650–1749 have been adjusted to take account of the practice of some parents who registered the burials, but not the births, of their children with the two meetings. The resulting corrections are relatively minor for the eighteenth-century cohorts, but those for the seventeenth are substantial, of the order of 30 per cent. The rationale for these adjustments is given in Landers, op. cit., note 12 above, appendix, together with a detailed examination of the reliability of the data. They are unlikely to be greatly in error, but the corrected rates for the seventeenth century may be a little too low. The numbers of risks on which the infant rates are based are 1743, 1852, 907 and 601 for the cohorts born 1650–99, 1700–49, 1750–99 and 1800–49.

[19] See E. A. Wrigley, 'Births and baptisms: the use of Anglican baptism registers as a source of information about the numbers of births in England before the beginning of civil registration', *Population Studies*, 1977, **31**: 299.

[20] The parish register infant mortality rates quoted in table 3 embody Wrigley and Schofield's proposed corrections for under-registration. The uncorrected rates for the four cohorts are 161·3, 166·7, 169·2, 133·4.

[21] M. W. Flinn, *The European demographic system*, Brighton, Harvester Press, 1981, appendix, table 10, 132–7.

[22] J. Knodel, 'Infant mortality and fertility in three Bavarian villages: an analysis of family histories from the nineteenth century', *Population Studies*, 1968, **22**: 297–318; J. Knodel and E. Van de Walle, 'Breast feeding, fertility and infant mortality: early German data', ibid., 1967, **21**: 109–32; J. Knodel, *Demographic behaviour in the past*, Cambridge University Press, 1988, ch.3.

Studies of urban populations are, as I have indicated, less numerous, but such as are available also suggest that mortality in London was unusually high. Perrenoud[23] calculated a rate of 296 per thousand for Geneva in the period 1580–1739, whilst the figures for the insalubrious Le Havre suburb of Ingouville, in the period 1730–70, was only 186.[24] Galliano's[25] study of nineteen parishes on the southern outskirts of Paris in the last quarter of the eighteenth century yielded a mean rate of 177, although the figures for individual parishes varied between 134 and 296.

Early in the following century, however, our study population began to overtake the Parisians. The estimates of infant mortality for the Seine department prepared by Preston and Van de Walle[26] fluctuate between 179 and 200 per thousand over the first half of the century, suggesting that the London Quakers were experiencing appreciably lower levels of mortality by mid-century, having entered the post-Napoleonic era in a roughly similar position.

The contrast between London and other Europeans capitals later in the century was dramatic. In the 1860s the published infant mortality rate for Berlin[27] was 297 per thousand whilst that for Stockholm in the preceding decade was 322.[28] Mortality in London had thus improved dramatically, in both absolute and relative terms, since the middle of the eighteenth century, but for how long had the already high levels

TABLE 4. INFANT MORTALITY IN SIX LONDON PARISHES
(rates per thousand)

	Parish	*– 1653*	*1690s*
1.	All Hallows, Bread St.	111	209
2.	St Peter Cornhill	129	215
3.	Christopher Le Stocks	88	155
4.	St Michael Cornhill	133	169
5.	St Mary Somerset	272	182
6.	St Botolph Bishopgate	211	176
	Mean	157	185
	Mean of Parishes 1–4	115	187

Source: R. A. P. Finlay, 'The accuracy of the London parish registers, 1580–1653', *Population Studies*, 1978, **32**: tables 2 and 6

detectable in the late seventeenth century prevailed? Finlay's[29] study of six London parishes indicates a sharp rise in infant mortality in the second half of the seventeenth century (see table 4), but the figure he obtained for the 1690s was still below 200 per thousand. Inspection of the results for individual parishes, however, suggests that the

[23] A. Perrenoud, 'L'inégalité devant la mort à Génève au XVIIème siècle', *Population*, (num. spec.) 1985, **30**: 221–43.

[24] M. Terrisse, 'Un Fauborg du Havre: Ingouville', ibid., 1961, **16**: 285–300.

[25] P. Galliano, 'La mortalité infantile dans la Banlieu Sud de Paris à la fin du XVIII siècle (1774–94)', *Annales de Démographie historique*, 1966, 137–77.

[26] S. H. Preston and E. Van de Walle, 'Urban French mortality in the nineteenth century', *Population Studies*, 1978, **32**: 275–97.

[27] J. Knodel, *The decline in fertility in Germany 1871–1939*, Princeton University Press, 1974, 159.

[28] G. Fridlizius, 'Sweden', in W. R. Lee (ed.), *European demography and economic growth*, London, 1979, table 9.20, p.392.

[29] R. A. P. Finlay, 'The accuracy of the London parish registers 1580–1653', *Population Studies*, 1978; **32**: 95–112.

latter figure may be something of an underestimate since the two poorest parishes in Finlay's sample, St Mary Somerset and St Botolph Bishopsgate, show an apparent improvement against the general trend. Had the rates for these parishes remained as they were at mid-century, then the rate for the sample as a whole in the 1690s would have been a little over 200, whilst it would have exceeded 250 per thousand had the two exhibited the same trend as the other four.

In view of this rather suspicious improvement, one is tempted to suspect that the "true" figure for the sample as a whole may have been closer to that obtained from the Quaker registers than it was to the 185 per thousand given by Finlay. This suspicion is strengthened by the rates of 246 and 333 per thousand quoted by Wrigley[30] for the parishes of St Vedast and St Michael Cornhill in the 1680s. Taking these figures together, it seems safe to conclude that London in the late seventeenth century was experiencing levels of mortality which were higher than in earlier decades. In the following century the position worsened still further and London seems to have become appreciably less healthy than a number of cities on the Continent. I shall now examine these trends in greater detail under three headings according to age: infant mortality, mortality in childhood, and adult mortality.

INFANT MORTALITY

The categories used by the searchers to classify causes of death are hard to translate into those of scientific medicine, and this is particularly true of those employed to describe infant mortality. Labels such as "teething" or "convulsions" might denote deaths from any of a number of distinct diseases, and there is no guarantee that they were always employed in a consistent fashion.[31] My analysis of infant mortality will thus be based on the techniques developed for use with sources in which explicit references to causes of death are absent. These rely chiefly on the distribution of infant deaths within the first year of life and, to a lesser extent, on the seasonal incidence of such deaths.

Analysis of age patterns of mortality have been strongly influenced by the biometric model formulated by Bourgeois-Pichat,[32] which partitions the overall mortality rate into components arising from so-called "endogenous" causes, present at birth, and "exogenous" causes arising from subsequent encounters with the external environment. These quantities are determined by calculating the cumulative deaths sustained by a cohort at successive intervals during the first year of life and plotting the resulting totals against a logarithmic transformation of age in days. In principle, the totals should increase linearly against transformed age after the first month of life, reflecting the action of exogenous causes, and the numbers of deaths arising from endogenous causes can be obtained by projecting this increase back to the origin at age zero days. The application of this technique to English family reconstitution data has, however, yielded unexpected findings, since levels of endogenous mortality have

[30] Wrigley, op. cit., note 19 above, 281–382.

[31] For a detailed analysis of the problem of causes of death in London at this time see J. M. Landers and A. J. Mouzas, 'Burial seasonality and causes of death in London 1670–1820', *Population Studies*, 1988, **42**: 59–83.

[32] J. Bourgeois-Pichat, 'La mesure de la mortalité infantile', *Population*, 1951, **6**: 233–48.

proved both high and variable, relative to exogenous mortality, in studies of registers from the sixteenth and early seventeenth centuries, and the reverse has held true in studies of more recent material.[33]

The scale of this phenomenon is hard to account for in terms of a rigid interpretation of the biometric model, and an alternative interpretation has been advanced by R. E. Jones[34] to explain the findings of his study of registers from some sixty parishes in north Shropshire from the sixteenth to the nineteenth centuries. This period witnessed a substantial reduction in infant mortality, but also a major change in its structure. In terms of the biometric model:

> this transformation had three major aspects—a very large decline in endogenous mortality, taking place between the mid-seventeenth and the mid-eighteenth centuries, a halving of exogenous mortality during the first three months of life, taking place mainly in the late eighteenth century, and a doubling of mortality during the second half of the first year of life, taking place around 1710.[35]

Jones argued, however, that such an interpretation would be misconceived and that the high initial levels of mortality from apparently endogenous causes were an artefact of the analysis. The period between the middle of the seventeenth century and the opening decades of the eighteenth should, he suggested, be seen as one of transition between two distinct epidemiological regimes in which a historically older pattern, dominated by high neonatal mortality arising from respiratory infection, gave way to a "modern" incidence of high mortality later in the first year of life, arising from the familiar "childhood" infections such as smallpox and measles.

My own data as set out in the first four columns of table 3 also indicate a marked shift in the age incidence of infant mortality. In particular, the overall reduction from the early eighteenth-century peak is primarily a consequence of the great diminution of risks associated with the first three months of life. This conclusion arises even more strongly from a comparison of the figures for the 1800–24 cohort with those for the first cohort in the series. Mortality at ages less than three months falls by more than 60 per cent, whereas that at ages above six months remains at a higher level in the early nineteenth century than it was at the beginning of the study period.

The application of the biometric model to this data yields estimates of endogenous mortality similar to those found in other studies (see table 5). These remain at a high plateau for the first century, giving way to a sharp decline after 1750 which continues into the nineteenth century and takes the final figure to the 14 per thousand given by the Registrar-General for London as a whole in the late 1840s.[36] The exogenous component, by contrast, rises sharply after 1700 and remains at a high level until the last quarter of the century, showing some increases after 1750, before falling to a level around 80 per cent of that prevailing in the later seventeenth century.

[33] R. S. Schofield and E. A. Wrigley, 'Infant and child mortality in the late Tudor and early Stuart period', in C. Webster (ed.), *Health, medicine and mortality in the sixteenth century*, Cambridge University Press, 1979, 61–96; Wrigley, op. cit., note 19 above.

[34] R. E. Jones, 'Further evidence of the decline in infant mortality in pre-industrial England: N. Shropshire 1561–1810', *Population Studies*, 1980, **34**: 239–80.

[35] Ibid., 244.

[36] Wrigley, op. cit., note 19 above, 299.

TABLE 5. COMPONENTS OF INFANT MORTALITY AMONG LONDON QUAKERS
(rates per thousand)

Cohort	*Exogenous*	*Endogenous*
1650–74	175	76
1675–99	183	80
1700–24	267	75
1725–49	260	81
1750–74	284	43
1775–99	183	48
1800–24	167	27
1825–49	137	14

Source: reconstitution tabulations

Components of Infant Mortality in Four English Family Reconstitutions
(means)

Cohort	*Exogenous*	*Endogenous*
1650–99	70	75
1700–49	79	100
1750–99	48	85

Source: E. A. Wrigley, 'Births and baptisms: the use of Anglican baptism registers as a source of information about numbers of births in England before the beginning of civil registration', *Population Studies,* 1977, **31**: 288

The explanation of these trends depends heavily on whether we choose to accept the orthodox interpretation of the "endogenous" and "exogenous" components or opt instead for the alternative view advanced by Jones. The evidence for the latter consists of two features of the data from the period of high neonatal mortality: first, the curve of accumulated deaths within the first year of life was not linear under the Bourgeois-Pichat transformation; and second, there was evidence of marked seasonal variation in the incidence of the supposedly "endogenous" neonatal deaths.

Jones found that the curve of infant deaths obtained from the earlier part of his study period was markedly convex, a shape that made the estimation of a "true" rate of endogenous mortality a matter of some difficulty but which bore a strong resemblance to those obtained in several reconstitutions from Atlantic coastal parishes of France,[37] where the authors suggested that respiratory infections were responsible for an accelerated build-up of infant deaths in the early months of life. Further evidence in support of this contention was provided by Jones's demonstration of a winter peak in the mortality of neonates in his sample of north Shropshire parishes, an observation hard to reconcile with an endogenous cause of death but entirely consistent with the alternative hypothesis. In our own case, the shape of the mortality curve (see figure 2) obtained by pooling data from the cohorts 1650–1749 shows no appreciable deviation from linearity, a slight convexity up to 90 days being offset by a tendency to kink upwards thereafter.

THE SEASONALITY OF BURIALS

The seasonal distribution of infant burials at successive infant ages in the London

[37] Y. Blayo and L. Henry, 'Données démographiques sur le Bretagne et l'Anjou de 1740 à 1829', *Annales de Démographie Historique*, 1967, 142–71; Terrisse, op. cit., note 24 above.

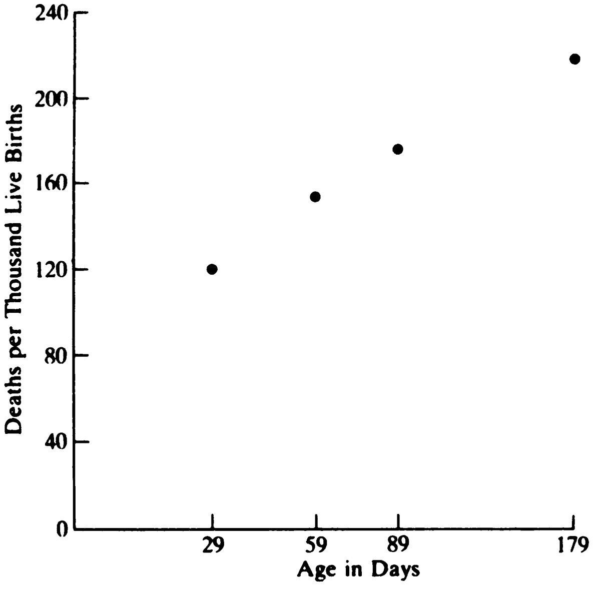

Figure 2. Biometric analysis of infant mortality 1650–1749.

Quaker sample was thus examined and appropriate seasonality indices constructed.[38] The figures for the cohorts born after 1750 were pooled in view of the relatively small number of observations in this period (see table 6) and the seasonal indices for burials

TABLE 6. SEASONALITY OF INFANT BURIALS
NUMBERS OF OBSERVATIONS BY AGE AND COHORT

	1650–99	*1700–49*	*1750–1849*
Age in Days			
0– 30	321	302	119
31– 90	120	176	85
90–179	115	114	83
181–	197	237	158

Source: reconstitution tabulations

at ages below 90 days were weighted to take account of the seasonality of births (see figure 3).[39] The analysis revealed substantial variations in the seasonal incidence of infant death, but these did not in general conform to the expectations of Jones's

[38] The seasonality indices were constructed in the conventional manner and express the proportion of events falling in a given season relative to the length of the season in days. Thus if the incidence of events was distributed evenly across the year, each seasonal index would be equal to 100. Conversely, a figure of 200 for a given season would indicate that twice as many events had occurred in that season as would be expected on the basis of an even distribution.

[39] The indices for burials at ages below 31 days were weighted by the reciprocal of the relevant birth seasonality index. In the case of burials at ages 30–89 days the reciprocal of the combined birth indices for the season in question and the preceding season, weighted in the relative proportions two to one, was employed. These procedures, although necessarily inexact, should remove most of the distributing effects of seasonal variations in the numbers of births. For a more sophisticated procedure, employing nominal record linkage, see Knodel, op. cit., note 22 above, 60–68.

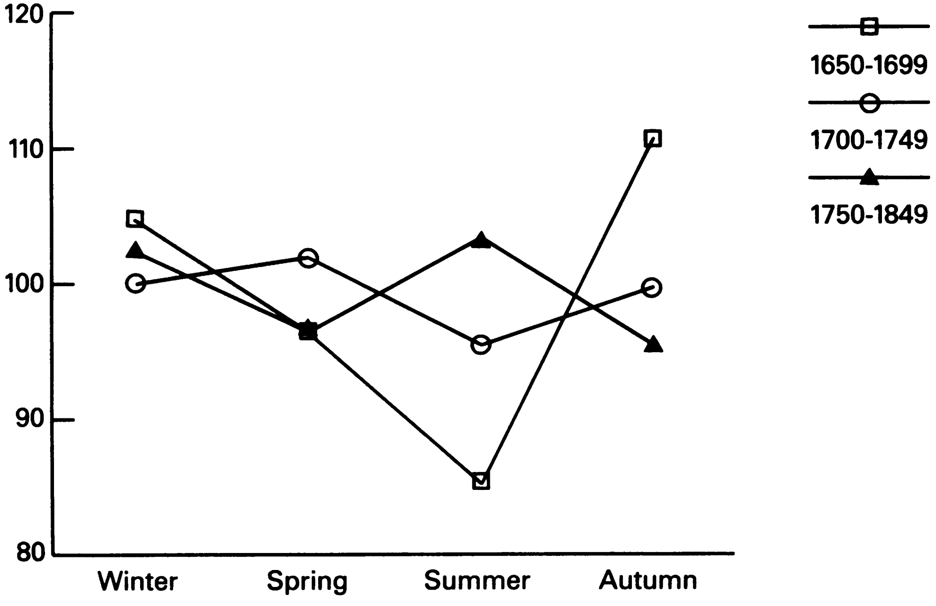

Figure 3. Seasonal incidence of births.

hypothesis. Deaths in the 0–29 day age-group (see figure 4) show a strong seasonal peak in the summer months (June–August) throughout the period, although this peak weakens somewhat in the second cohort (1700–49). The index for autumn (September–November) is close to 100 for all cohorts, and those for winter and spring (December–February and March–May) fall below this level, the spring index being particularly low after 1750.

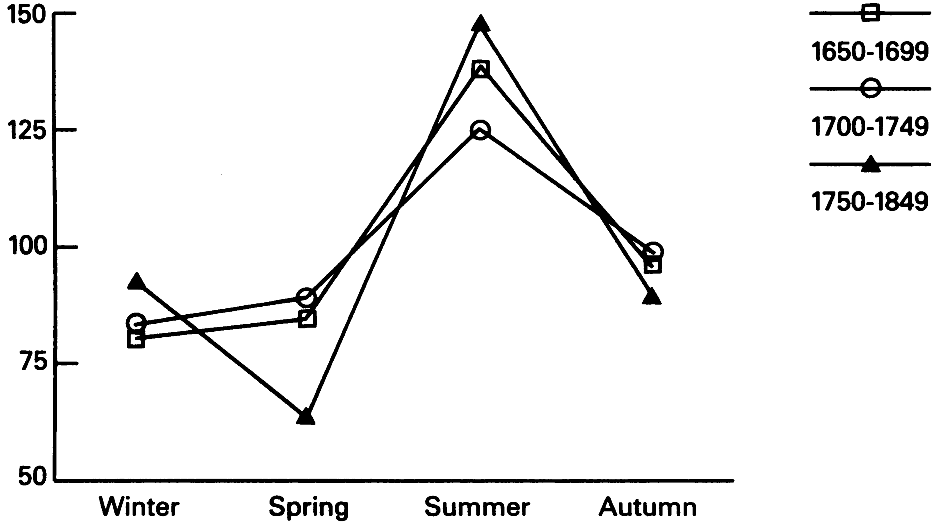

Figure 4. Seasonality of infant deaths: 0–29 days. Weighted by seasonality of births.

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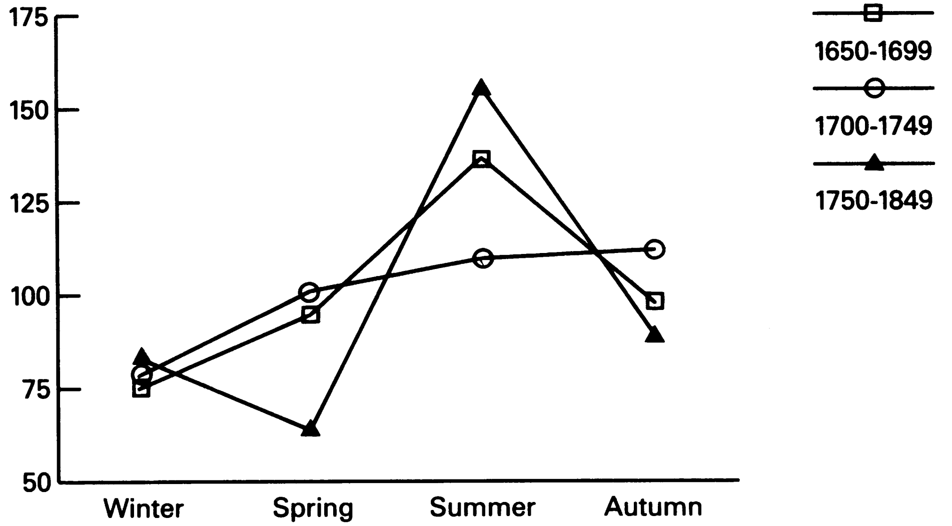

Figure 5. Seasonality of infant deaths: 30–89 days. Weighted by seasonality of births.

The seasonality of deaths in the 30–89 day age group changes rather more over the period (see figure 5). Cohorts born before 1700 and after 1750, display a strong summer peak with the latter cohort also showing a clear spring trough, but the excess summer mortality almost disappears in the middle cohort (1700–49) in the face of a small rise in the autumn index. The results for the 3–5 month age groups, by contrast, do show substantial excess mortality in the winter, and particularly in the spring months, until 1750 (see figure 6). Such an excess is consistent with the action of the respiratory infection postulated by Jones, but its disappearance after 1750 is associated with only as modest reduction in mortality. The seasonal profile of deaths in the oldest age group

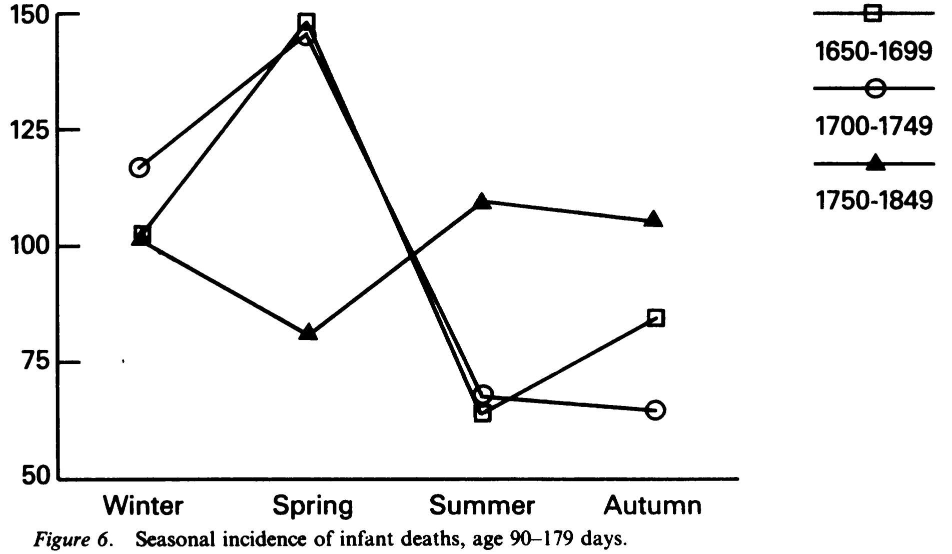

Figure 6. Seasonal incidence of infant deaths, age 90–179 days.

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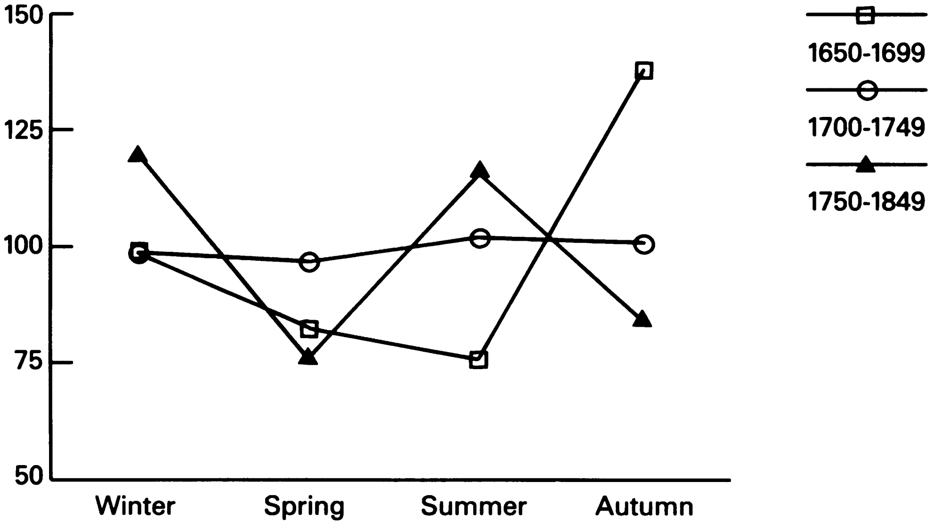

Figure 7. Seasonal incidence of infant deaths, age 180+ days.

(see figure 7) evolves from one of excess autumn mortality in the first cohort, combined with a pronounced spring and summer trough, through an almost flat pattern between 1700 and 1749, to a bimodal distribution in the century after 1750, with excess mortality in both winter and summer and a deficit in the spring and autumn.

The data for the first two cohorts taken together are sufficiently numerous to bear analysis on a monthly basis. In figure 8 I have split the first month of life into ages 0–9 and 10–29 days, calculating separate indices for each with appropriate allowance for the monthly distribution of births. The scale of the August burial peak in the older of

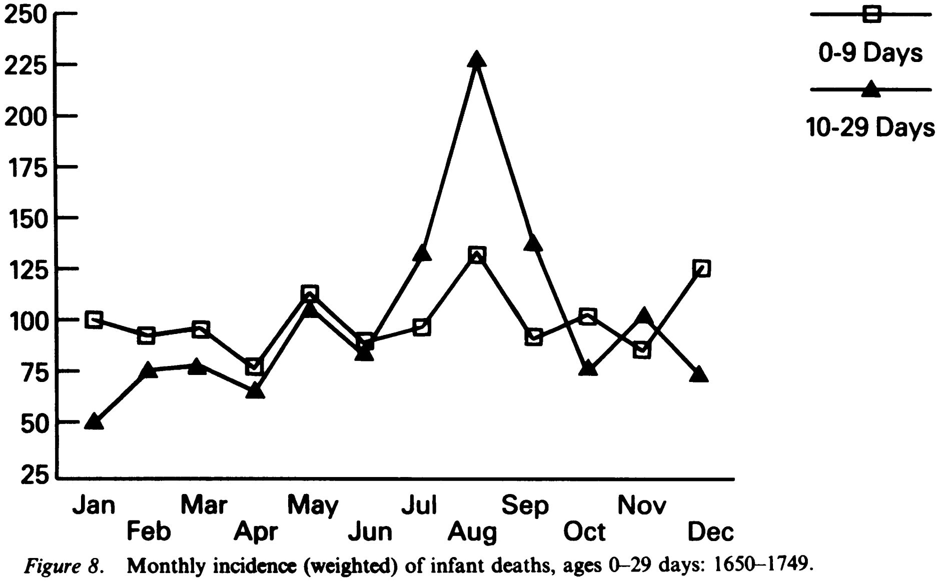

Figure 8. Monthly incidence (weighted) of infant deaths, ages 0–29 days: 1650–1749.

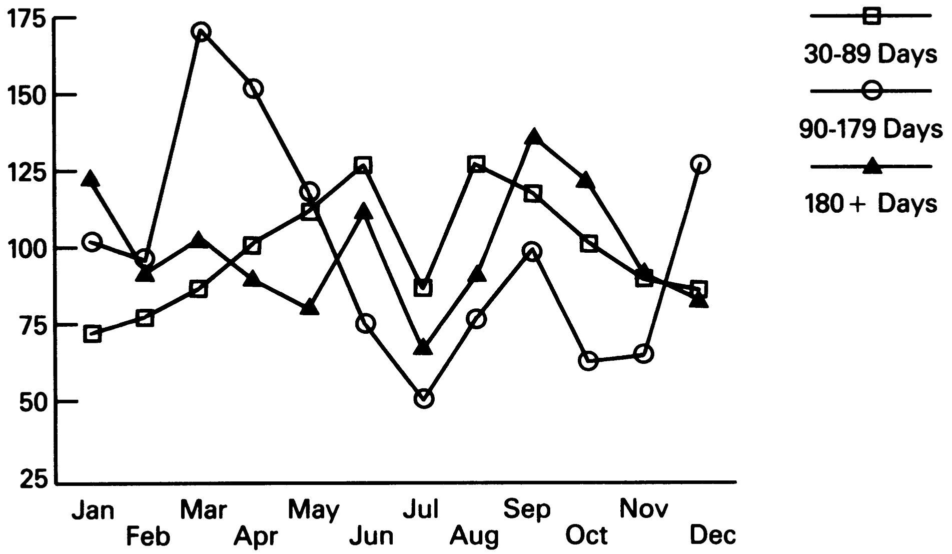

Figure 9. Monthly incidence of infant deaths at ages above 30 days: 1650–1749.

these two age groups is striking, but infants under 10 days also suffer an excess August mortality of some 25 per cent, suggesting a significant level of artificial feeding from very close to birth, if not from birth itself. The monthly pattern of mortality at ages between 30 and 179 days (see figure 9) broadly reflects that seen in the indices for the four seasons, although the scale of the July trough is unexpected. In the case of the older age group, however, the autumn excess proves to be heavily weighted toward September, the index value having fallen below 100 by November, and might thus be more accurately labelled as "late summer/early autumn".

The interpretation of these diverse movements is far from straightfoward, but I can attempt some explanations.[40] In the first place, the excess summer mortality observed in the youngest age groups suggests that the infants were exposed to the risks of water-borne, and particularly food-borne, infections and thus that artificial feeding was widely practised from an early age. This practice has, as we have seen, often been associated with high levels of early infant mortality in historical Europe, and it seems plausible to attribute the severe neonatal mortality detected in the early cohorts of the present study to such a cause. If this attribution is correct, however, the maintenance of the summer excess into the second half of our period undiminished, at a time when neonatal mortality was falling steeply, implies that the practice continued among an ever-diminshing fraction of the reconstituted families who in turn furnished the bulk of neonatal deaths.

[40] It should be noted that substantial shifts occurred in the overall seasonal distribution of burials in London over the period with which we are concerned (see Landers and Mouzas, op. cit., note 31 above), although these seem to have affected mortality at childhood ages more than they did infants or adults. Substantial spatial variations in the seasonality of childhood mortality developed in the latter part of our period, but such variation was apparently relatively unimportant before 1750. For an analysis of burial seasonality in London by age and district see J. M. Landers, *Death and the metropolis: studies in the demographic history of London (1670–1841)*, Cambridge, 1992, in press, chs. 6 and 8.

The behaviour of the figures for the age groups 2–3 and 6–11 months suggests that any "new" diseases implicated in the rise in mortality after 1700 were either lacking in seasonal variation or else that their seasonal incidence complemented that already present. Either of these alternatives might be consistent with the action of airborne infection, and such an explanation might also account for the failure of infants in the 3–5 month age group to benefit more strongly from the apparent reduction in respiratory infection after 1750, assuming that the "new" infection remained active in an ameliorated form beyond this date.

POST-PARTUM INSUSCEPTIBILITY

The possibility that a "replacement" airborne infection may have been an important cause of such early infant deaths returns us to the question of methods of infant feeding. Breast-fed babies generally obtain a degree of immunity to such infections through the secretion of maternal antibodies in milk, and so the existence of widespread vulnerability among young infants in this respect would further imply the prevalence of early artificial feeding, whether permanently or only during the secretion of the maternal colostrum. Fildes[41] found that artificial feeding was recommended by some contemporary medical authorities and advice books, but direct evidence about Quaker practices is lacking.[42] An indirect estimate of the mean length of lactation is possible, however, because of the strong association between this interval and the duration of the post-partum non-susceptible period (NSP). The technique is based on a comparison of the mean interval from marriage to first birth (the protogenesic interval) with that between the first and second births (the first intergenesic interval). Since the major difference between these two is that the protogenesic interval excludes the NSP, the difference between the means should provide a rough indicator of the latter's duration and thus, indirectly, of the length of lactation.

The method suffers from some technical problems,[43] but all these will tend to exaggerate the estimate of NSP and so the results can safely be treated as an upper limit on its length. The possibility of systematic under-registration of first births relative to those of higher orders presents greater difficulties. Wilson[44] argues that, where Anglican parish registers are concerned, delayed baptism together with the practice of baptizing the first child in the mother's natal parish, leads to a spurious extension of the right hand "tail" of the distribution of protogenesic intervals biasing the mean estimate upward. Wilson dealt with this problem by excluding intervals of more than two years' duration and working with the resulting "trimmed" distributions. In the present case, however, there is no problem of baptismal delay whilst, in the latter periods particularly, the importance of birthright membership makes it unlikely that parents would fail to register their child's birth with their own meeting. I have thus adopted a more moderate criterion excluding protogenesic intervals of more than three years and

[41] V. Fildes, 'Neonatal feeding practices and infant mortality during the eighteenth century', *J. Biosocial Science*, 1980, **12**: 313–24.

[42] J. W. Frost, *The Quaker family in Colonial America*, London, 1973, 71–4.

[43] C. Wilson, 'Marital fertility in pre-industrial England 1550–1849', University of Cambridge, unpublished PhD thesis, 1982, 137–41.

[44] Ibid.

intergenesic intervals of over four years, resulting, for the period 1650–1749, in means of 15·1 months for the protogenesic interval and 20·2 for the first intergenesic interval, a mean difference of 5·1 months.

This is similar to results obtained by Finlay for his two "rich" City parishes, St Michael and St Peter Cornhill, in the period 1580–1650, and to those found in a number of French studies reflecting the influence of wet-nursing,[45] but contrasts sharply with Wilson's estimates of approximately eleven months for the mean NSP in a dozen English reconstitutions over the period 1650–1749. My result for the period 1750–1849 is only 3·5 months, but this implied reduction in mean NSP must be treated with great caution, for the birth interval distributions in this period display unusual features that suggest artificial prolongation and thus render them unsuitable for the present purpose.[46]

SPATIAL VARIATIONS

Some additional light can be thrown on the relationship between infant mortality, infant feeding, and hygiene by an analysis of spatial variations in the ratio of recorded infant deaths to births using the residential information reviewed above. An index of infant mortality was constructed for each group of parishes, by 50-year cohorts, such that $I_{-1} = 100$ where the ratio of infant burials to births in the ith group was equal to that obtained by pooling the observations from all groups. The results in table 7 reveal generally higher levels of mortality in the northern parishes than in those south of the river prior to 1800.

In the nineteenth century, however, the picture changes; the southern parishes now have higher mortality than the northern and, within each of these two major divisions, the newly expanding outer parishes have lower indices than the inner parishes—although the number of events in some of the northern parishes is too small to bear detailed analysis. In the lower panel of the table an attempt is made to assess the responsibility of residential movement for the mortality trends observed in the reconstitution study.

For each of the two periods 1750–99 and 1800–49 the overall infant burial ratio was computed using the observed ratios in each group of parishes for that period, but weighting these according to the spatial distribution of births observed in the period preceding it. The results suggest that changes in the spatial distribution of the population had little effect on the overall trend in infant mortality before 1800, but that movement to the suburbs beyond this date produced a level of mortality some 20 per cent below that which would have prevailed otherwise.

These results are of interest for two reasons. In the first place, they confirm that the reduction in infant mortality visible in the family reconstitution results after 1750 was genuine, and not an artefact of geographical movement. Second, they give some hints as to the causes of death. In particular, the higher mortality south of the river, and the greater contrast between "old" and "new" areas here than in the north, may reflect differences in the quality of the water supply. After 1800, London's expansion was

[45] Finlay, op. cit., note 8 above, 134, and appendix table 3.

[46] For a discussion of this question see J. M. Landers, 'Birth spacing and fertility decline among London Quakers', in J. M. Landers and V. Reynolds (eds), *Fertility and resources*, Cambridge, forthcoming.

TABLE 7. INDEX FIGURES FOR RATIO OF INFANT BURIALS TO BIRTHS BY PARISH GROUPS

	1700–49	*1750–99*	*1800–49*
Group 1	100	91	–
Group 2	159	67	–
Group 3	134	117	60
Group 4	142	147	125
Groups 1–4	127	107	85
Group 5	88	79	118
Group 6	124	140	176
Group 7	117	88	89
Group 8	64	120	186
Groups 5–8	91	96	108
Index Base (100 =)	·527	·276	·136
Base if No Spatial Changes	–	·298	·174

Source: see text

Parish Groups

Northern

1. St Botolph Aldersgate, St Batholomew Great and Less, St Sepulchre
2. St Bride, St Dunstan, Holborn
3. Clerkenwell, Islington
4. St Giles Cripplegate, St Luke

Southern

5. Bermondsey, Rotherhithe
6. Christ Church, Surrey, St Saviour, Southwark
7. St George, Southwark, Lambeth, Newington Butts, Camberwell
8. SS John, Olave, Thomas, Southwark

greatly affected by the development of piped water. Much difficulty was encountered in maintaining a supply, which was taken from the Thames and inadequately filtered, to the low-lying areas immediately south of the river. Districts further south, however, such as Camberwell, were supplied with water from springs in the gravel hills. Hence the mortality differentials in the early nineteenth century may reflect the contrast between domestic water supplies which were pure and relatively abundant and those which were polluted and liable to disruption.[47] Ecological variation of this kind is, in turn, consistent with the hypothesis of gastric diseases as the major mortality factor among certain age groups in this period.

SUMMARY

The trend in overall infant mortality can thus be broken down into movements in a number of components whose behaviour was partially independent of each other:

1. *Gastric disease among older infants.* This is visible, in terms of seasonality, throughout the study period, with the exception of the cohorts born 1700–49. There seems little reason to believe that its severity varied greatly over the period.

[47] H. J. Dyos, *Victorian suburb: a study of the growth of Camberwell*, Leicester University Press, 1961, 36–7, 143–5. A. Hardy, 'Water and the search for public health in eighteenth- and nineteenth-century London', *Med Hist*, 1984, **28**: 250–82.

2. *Gastric disease among infants in the first month of life.* The seasonality data suggest that this was present throughout the period but it apparently declined greatly in severity from the later eighteenth century. The prevalence of such infections among the newborn suggests the practice of artificial feeding, a suggestion supported by the birth interval data. Polluted water supplies may have played an important part in maintaining both (1) and (2).
3. *Respiratory diseases in young infants.* This—the "Jones factor"—is in some ways the most enigmatic. The figures for the 3- to 5-month age group display the expected seasonality in the first half of the period. The behaviour of the younger age groups, however, is less clear-cut. The 1- to 2-month group accounts for a substantial part of the overall reduction in mortality, and its mortality rates move in parallel with those at 3–5 months, but there is no apparent seasonal pattern to mortality among the former and in its absence the status of the "Jones factor" cannot be clearly established one way or the other.
4. *Aerosol infection in older infants.* We have suggested that the "hump" in the mortality rates of the 6- to 11-month age group, in the first half of the eighteenth century, arises from an aerosol infection whose effects were sufficiently severe to obscure those of the underlying seasonality of gastric infection. This factor may also have had some effect on the mortality of younger infants.

SMALLPOX AND CHILDHOOD MORTALITY

The rates of childhood mortality obtained from the reconstitution study surpass those found elsewhere in eighteenth-century England even more than is the case with infant mortality. The trend in mortality rates at ages one year and over among the London Quaker families also differed from that experienced by other communities outside the capital. The study of mortality at these ages is simplified by the predominance of a single cause of death—smallpox. Smallpox is, moreover, one of the few diseases reliably identified as such by the searchers, and our data are uniquely valuable in that they allow a double classification of deaths by both age and cause.

In view of the particular interest of this topic, a special study was undertaken using the smallpox entries from the burial registers of all six of the London Quaker monthly meetings. This material was used to examine the age distribution of smallpox mortality and then, by linking these results to those obtained from family reconstitution, it was possible to estimate age-specific mortality rates for the disease and thus to assess its impact on overall levels of mortality in childhood.

The recorded totals of smallpox casualties, classified by age, are given in table 8 for the six meetings and for Peel and Southwark separately. In both cases, children under five form the majority of entries in each of the 50-year periods, but between 25 and 35 per cent of cases are in the adolescent or young adult age groups. These figures, however, require some adjustment, for the cause of death is sometimes absent, and the likelihood of its being omitted itself varies with age. This difficulty was overcome, in the case of the Peel and Southwark registers, by examining a sample of some 2,000 burial entries for the two meetings and determining the proportions lacking cause of death information in each age group. These were then used to calculate appropriate adjustment factors and thus obtain the corrected proportions given in table 9.

TABLE 8. AGE DISTRIBUTION (%) OF SMALLPOX BURIALS IN LONDON QUAKER MEETINGS

	Peel and Southwark			*All London Meetings*		
Age Group	*1650–99*	*1700–49*	*1750–99*	*1650–99*	*1700–49*	*1750–99*
0–1	29·2	17·6	28·2	26·5	17·7	31·3
2–4	23·2	31·2	25·9	24·5	31·2	29·4
5–9	10·3	14·6	18·5	10·6	14·1	13·4
10–9	11·9	10·5	6·5	15·3	10·6	7·0
20–9	18·4	16·9	14·5	15·7	17·2	11·4
30–9	4·3	4·1	4·0	4·9	4·2	3·2
40–9	2·2	2·7	1·6	1·9	1·6	2·3
50–	·5	2·4	·8	·6	3·4	2·0
N	191	300	124	470	615	343

Source: see text

The proportion of casualties falling in the younger age groups is now somewhat greater than before, since it was here that causes of death were most often omitted, but the fraction aged over ten years remains substantial. A substantial proportion of adolescents and young adults in London's population thus lacked immunity to smallpox. The most plausible interpretation of this finding is that these individuals were immigrants from the countryside, since the disease may well have been universal among children born in the capital: in no case was it possible to link the burial entry of a smallpox casualty aged more than ten years, in the Peel and Southwark burial register, to an entry in the birth registers of either meeting. Such a result is suggestive of very high levels of immunity among the native-born population in the older age groups.[48]

The adjusted distributions of casualties classified by age, as taken from the Peel and Southwark registers, can be used to determine the probability of dying from smallpox in childhood. As a first step we must retabulate the results so as to indicate the proportions of all deaths at each stage which are due to the disease. This can be done using the distributions of ages taken from the 2,000 burial slip sample to indicate the age distribution of all deaths in the population, leading to the distribution in the right-hand columns of table 9. The latter strikingly demonstrates the importance of smallpox as a mortality factor among children in the first half of the eighteenth century. Nearly half of all lives lost in the 5- to 9-year age group, at this time, were due to the disease, but smallpox was evidently an important influence on death rates at all ages between one and thirty years throughout the period covered by the data. The next step is to apply these proportions to the mortality probabilities calculated from the family reconstitution data.

Such a procedure is justified on the assumption that smallpox's share in the deaths occurring among the reconstituted families was equal to that observed in the burial registers as a whole. The differing susceptibilities of natives and immigrants makes this

[48] The very low proportions of smallpox burials falling in the age groups above the age of 30 imply substantial immigration in the 10–29 age group, and the findings as a whole indicate that a substantial proportion of the adult population outside London had escaped exposure to the disease. This is in marked contrast to other populations, such as Sweden, where the proportion of smallpox burials above the age of ten was of the order of 5 per cent or below, implying near-universal exposure in childhood (see Landers, op. cit., note 12 above, 198–201), I am grateful to Dr R. S. Schofield for drawing my attention to these points.

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TABLE 9. CORRECTED DISTRIBUTIONS OF SMALLPOX BURIALS—PEEL AND SOUTHWARK

	Burials (%) by Age			*As (%) of Total in Age-Group*		
Age	*1650–99*	*1700–49*	*1750–99*	*1650–99*	*1700–49*	*1750–99*
0	15	16	14	3	7	4
2–4	36	45	48	10	29	26
5–9	10	13	16	16	44	29
10–9	13	9	5	15	23	14
20–9	18	11	11	12	18	16
30–9	5	3	4	5	4	4
40–9	2	2	1	–	3	1
50–	1	1	1	–	1	–

Age Specific Mortality Rates (q_x) Per Thousand Eliminating Direct Effects of Smallpox

Age	*1650–99*	*1700–49*	*1750–99*
6–11 months	71	97	85
1 year	102	123	87
2–9 years	185	171	155
1–9 years	268	273	229

(For explanation see text)

assumption untenable for adolescents and young adults, but it is unlikely to be too far out where children under ten are concerned. In the case of infant deaths, I have related smallpox burials to deaths at ages 6–11 months, since it has been claimed that vulnerability to the disease below this age is minimal.[49] The effect of smallpox on childhood mortality among the reconstituted families was estimated on the assumption that the probability of death from the disease was independent of that from other causes. It is unlikely that the prevalence of other causes of death aggravated the risks from smallpox on any significant scale, but the converse may well have been the case if survivors of the disease were so weakened that they succumbed to maladies that otherwise would not have proved fatal. If this were so, then my calculations would tend to underestimate the overall contribution of smallpox to mortality levels.

Mortality probabilities (q_x) can be calculated eliminating the effects of this disease by assuming that those whose lives were thus saved were thereby exposed to the same risks of death from all other causes as was observed among those surviving the risk of death from smallpox among the reconstituted families. If we divide the life table deaths at age x into two groups: $d(1)_x$, who die of smallpox; and $d(0)_x$, who die from all other causes, then:

$$q_x = [d(0)_x + ((d(1)_x . d(0)_x)/1_x)]/1_x$$

The results in the lower panel of table 9 suggest that the increase in childhood mortality observed after 1700 is entirely attributable to smallpox. Only between the ages of six months and two years does this increase persist once the direct effects of the disease are removed. This removal lowers the overall risk of death between the ages of

[49] P. E. Razzell, *The conquest of smallpox*, Firle, Sussex, Caliban Books, 1977, 105–6.

one and ten years by about 25 per cent in both halves of the eighteenth century, but only by some 10 per cent in the period prior to 1700. In the second year of life, this reduction is much smaller and the adjusted rate rises by about 20 per cent in the early eighteenth century.

Smallpox cannot, therefore, be the sole explanation for the increased mortality between six months and two years of age, but it does account for a substantial fraction of it. The decline in the mortality of children over two years of age, after 1750, is likewise explicable mainly in terms of smallpox, but a substantial decline in the mortality of the one-year-olds persists when the effects of the disease are removed. Above this age, the estimates of childhood mortality in the absence of smallpox show a very modest reduction in each period, the hypothetical "smallpox-free" rate for the cohort 1750–99 being close to the childhood rates actually observed in the first quarter of the nineteenth century. Smallpox mortality itself evidently rose sharply in the early decades of the eighteenth century and fell again after 1750. The spread of inoculation may well explain the decline and it is particularly frustrating that the absence of cause-of-death information in the nineteenth-century registers prevents us from following its progress beyond 1800.[50]

ADULT MORTALITY AND THE EXPECTATION OF LIFE

The third and final age category which I shall examine is the "adult" series, a heading under which it is also convenient to consider the question of overall life expectancy. There are two ways in which adult mortality rates can be estimated from family reconstitution data, both of them yielding results of a more approximate character than is the case with the younger age groups. The first method is based on the recorded burials of husbands and wives in the reconstituted families. Only a proportion of deaths among this group is recorded, however, and so assumptions must be made about the fate of the survivors who pass out of observation in other ways.

This results in a range of estimates falling between "optimistic" and "pessimistic" limits. The latter is given by the assumption that these survivors are immediately exposed to the same risks of mortality observed among those whose deaths are recorded, whereas the former is based on the assumption that such persons all survive to the age of sixty before they encounter the observed risks of mortality. Since the observed distribution of deaths is biased downwards, Wrigley suggests that the "true" rates of adult mortality will lie closer to the optimistic than to the pessimistic end of the interval.[51]

The reliance on recorded burials of married persons necessarily restricts our calculations to age groups in the mid-20s and above, hence we must look elsewhere for data on the mortality of adolescents and younger adults. These can be obtained from model life tables fitted to the observed infant and child mortality rates. Model life tables can also be used as a basis for estimating mortality at all ages above fifteen, the

[50] The spread of inoculation and its demographic effects are discussed by Razzell, ibid. For a recent review of the problem, including a discussion of the later impact of vaccination, see A. J. Mercer, 'Smallpox and epidemiological-demographic change in Europe: the role of vaccination', *Population Studies*, 1985, **39**: 287–308.

[51] E. A. Wrigley, 'Mortality in England: Colyton over three centuries', *Daedalus*, 1968, **97**: 546–80.

second of these two methods referred to above, but I shall employ the first method, which makes more use of the actual observations.

The Princeton Regional Model Life Tables constructed by Coale and Demeny[52] were used in the analysis, as they have the advantage of providing four "families" of tables based on the experience of populations denoted "West", "East", "North", and "South". The "West" tables are based on survival curves found in a series of particularly well-documented European countries, whereas the others describe particular divergent patterns. Of these the North and South families have particularly high rates of mortality in childhood relative to those in infancy. The former generally give the best fit to English reconstitution results,[53] whilst the latter have successfully been applied to data from other metropolitan populations.[54] In the present case, the North tables provided a good description of the observed rates for the 1800–49 cohort, whilst the South series did better before this date, and the appropriate "bridging rates" were selected accordingly.[55] The results in table 10 suggest that mortality above the age

TABLE 10. ESTIMATED LIFE EXPECTATION FOR LONDON QUAKERS

	Mid-Range		*Range*	
	Males	*Females*	*Males*	*Females*
At birth				
1650–99	27·3	30·2	25·9–28·7	28·7–31·7
1700–49	20·6	21·9	19·7–21·5	20·9–22·9
1750–99	29·7	29·9	28·5–31·0	28·5–31·2
1800–49–	34·2	36·7	32·3–36·1	34·6–38·9
At Age 30				
1650–99	28·0	29·3	24·8–31·2	25·8–32·7
1700–49	26·2	26·5	23·4–29·0	23·6–29·5
1750–99	30·9	32·6	28·2–33·5	29·7–35·5
1800–49	31·3	32·5	27·9–34·8	28·6–36·3

Source: reconstitution tabulations

Estimated Life Expectation at Birth in England
(medians of quinquennial estimates for combined sexes)

1650–74	34·1	1750–74	35·6
1675–99	34·1	1775–99	36·8
1700–24	36·4	1800–24	37·9
1725–49	32·4	1825–49	40·2

Life Expectation at Age 30: Means of 12 English Reconstitutions

Cohort	*Males*	*Females*
1650–99	28·4	28·9
1700–49	30·4	30·2
1750–99	32·1	32·4

Source: E. A. Wrigley and R. S. Schofield, *English population history*, London, 1981, tables 7.15 and 7.21

52 A. J. Coale and P. Demeny, *Regional model life tables and stable populations*, 2nd ed., London, 1983.
53 E. A. Wrigley and R. S. Schofield, *The population history of England 1541–1871: a reconstruction*, London, Edward Arnold, 1981, 708.
54 Perrenoud, op. cit., note 23 above; Preston and Van de Walle, op. cit., note 26 above.
55 Landers, op. cit., note 12 above, 154–6.

of thirty was relatively static throughout the period when compared with the experience at younger ages, the major change being an improvement of some five to six years in adult life expectation between the two halves of the eighteenth century.

Life expectation at birth was more volatile, falling from around thirty years in the later seventeenth century to little more than twenty years in the first half of the eighteenth. The later eighteenth century saw a major rise in life expectation at birth for both sexes, the male figure rising to a level above that of the later seventeenth century. Substantial improvement continued into the nineteenth century, but this did not appear to affect adult mortality.

A comparison of the adult estimates with figures obtained from other English reconstitution studies, in the lower panel of the table, shows surprisingly little overall difference in levels of mortality. The main contrast is one of trend, since the rates for the parish sample show a progressive improvement throughout the period, whereas those for the London Quakers deteriorate after 1700, which leads to a differential of some four years in e_{30} for the 1700–49 cohort. The contrast in the e_o series, however, is dramatic—the national figure being nearly twice that for the London Quakers in the 1700–24 cohort. After 1750, the latter recover disproportionately and the differential remains at some five to six years for the remainder of the study period.

III

The outstanding feature of these results is the exceptional severity of infant and child mortality throughout much of the period, a severity that substantially bears out the traditional "high mortality" interpretation of metropolitan burial surpluses in early modern Europe. From the latter part of the eighteenth century, these levels of mortality declined dramatically, and by the end of the period there appears to have been little difference between the experience of our reconstituted families and that of the population nationally.[56]

The limited spatial analysis which I was able to undertake suggested that whilst some of this reduction might be attributable to residential movement, this was only the case after 1800 and was of secondary importance even then. My analysis of occupational labels in the vital registers also found no evidence of major structural change before the nineteenth century. A full explanation of these developments would need to draw on a broad range of external evidence as to social, economic, and epidemiological changes both in the capital and in the country at large.

The present study has, by contrast, a much more restricted ambit, being limited to a detailed scrutiny of the mortality rates themselves and of their internal structure, but this framework has enabled me to identify a number of partially independent factors underlying the high levels of mortality. Gastric disease, apparently linked to defective water supplies, seems to have been a major killer of older infants and "weanlings" throughout the period, and before the latter part of the eighteenth century it may also have claimed many lives among the newborn. A reduction in the rate for the first three

[56] Our mid-range estimates of life expectancy in the last cohort are also comparable with, though slightly higher than, Woods' recent estimates for London as a whole (see R. I. Woods, 'The effect of population redistribution on the level of mortality in nineteenth-century England and Wales', *J. econ. Hist.*, 1985, **45**: 645–51), which rise linearly from 30 years in 1811 to 33 in 1841.

months of life accounted for most of the long-term decline in infant mortality, but gastric diseases are unlikely to have been wholly responsible. There is evidence of deaths from respiratory infections in the 3- to 5-month age group before 1750 and, though we have not been able to establish this definitively, it is probable that these took their toll of neonates as well during the earlier part of the period. Infant mortality rose in the early eighteenth century because of an increase in the rate for the 6- to 11-month age group.

Mortality in the second year of life also increased at this time, and in both cases much of the increase was attributable to smallpox, with a substantial minority of the extra deaths coming from some other disease. I have not been able to identify the latter, but it is unlikely to have been food- or water-borne since the early eighteenth century sees a temporary disappearance of the characteristic summer peak in the mortality of older infants. A parallel rise in mortality at ages between two and ten years at this time reflected an increased incidence of smallpox deaths, but the overall difference between the levels of childhood mortality found in the present study and those found in other eighteenth-century English reconstitutions is too great to be accounted for by this disease alone.

Eighteenth-century London was evidently an extremely unhealthy place even for those who escaped the ravages of smallpox, but the prevalence of this disease apparently constituted a particular threat to the lives of immigrants, many of whom seem to have lacked immunity. The relatively narrow gap between metropolitan and national mortality levels above the age of thirty is consistent with Professor McNeill's[57] attribution of metropolitan burial surpluses to the action of density-dependent, immunizing infections. I have argued elsewhere[58] that other demographic data from London at this time support such an interpretation, but over-simplification of what was evidently a high-mortality regime should be avoided. Many of the excess deaths, for instance, arose from gastric diseases in infancy, and the heightened prevalence of these reflected environmental hazards and patterns of infant care rather than the action of an ineluctable "immunological determinism".[59] Changes in the virulence of infectious agents may explain some of the mortality trends revealed in this study. This is particularly true of the overall rise in mortality from the later seventeenth to early eighteenth centuries. The findings of Wrigley and Schofield[60] indicate that the general trend of mortality in England as a whole was downward at this time, but that this secular amelioration underwent a number of abrupt reversals in the decades after 1700. Such a pattern might be expected if the capital were acting as an endemic reservoir of infection whose heightened prevalence led to periodic eruptions in the form of widespread epidemic crises.

The scale of the mortality decline from the later eighteenth century is, however, altogether too great to be accounted for wholly in terms of some compensating immunological adjustment to new disease patterns. Respiratory infections in infancy

[57] McNeill, op. cit., note 4 above.

[58] Landers, op. cit., note 5 above.

[59] For an outline and critique of this concept see S. J. Kunitz, 'Speculations on the European mortality decline', *Econ. Hist. Rev.*, 2nd ser., 1983, **36**: 349–64.

[60] Wrigley and Schofield, op. cit., note 53 above.

may have undergone a "spontaneous" decline. Inoculation may have reduced the incidence of smallpox deaths, and changes in infant care may have saved many lives in their early months. But much of the reduction remains to be explained, and its significance cannot be overstated. By 1800, the long-established pattern of natural decrease in London's population had apparently disappeared, allowing the city to maintain itself without consuming substantial numbers of immigrants, and by 1850 little difference remained between the mortality of the capital and that of England at large.[61] The social and economic implications of this break with the demographic regime of early modern Europe are profound,[62] and its explanation must remain a central priority for future research in this field.

[61] Victorian England was, however, characterized by marked spatial differentials in mortality levels; see R. I. Woods, 'The structure of mortality in mid-nineteenth century England and Wales', *J. Historical Geography*, 1982, **8**: 373–94.

[62] De Vries, op. cit., note 1 above, ch. 10.