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Abstract

Medical knowledge – defined broadly to include both its private and public forms – has been the driving force behind the historical transitions that have raised life expectancy in modern Europe. Advances in knowledge, rather than better nutrition (particularly the escape from caloric insufficiency) deserve greater emphasis because the very first groups to undergo anything recognizable as a secular rise in longevity were the rich and well fed, rather than the poor and chronically *malnourished*. At the beginning of the 16th century Europe's ruling elites lacked virtually any reliable information about how best to use their ample material resources to prevent, manage and cure the ill-health that caused so many premature deaths among them. The advance of medical knowledge and practice accelerated in Western Europe after c. 1500, with a succession of discoveries that were quite useful (as judged by modern standards) in preventing disease, reducing "life-style" risks, managing illness and providing cures for a few debilitating and deadly diseases – severe dysentery, syphilis, malaria, scurvy and, finally, smallpox, being the principal diseases affected. Yet, access to most of the available innovative medical care remained closely restricted. Medical expertise was limited and highly priced, and many of the measures prescribed were unaffordable even to town-dwelling middling-income families in environments that exposed them to endemic and epidemic disease. Along with the poor, they therefore were left at a grave health disadvantage *vis-à-vis* adult members of the wealthy urban families to whose conditions the doctors were attending. The London-based ruling families of England in this epoch benefited to an exceptional degree among the European elites from the contemporary progress of medicine. Their improved chances of survival in adulthood were the major factor raising royal life expectancy at birth (males and females, combined) from 24.7 years for the cohort born during the 1600s to 49.4 years for those born during the 1700s.

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Introduction – From Royal to Global Life Expectancy History

Although royal mortality history may seem like a marginal topic of dubious value, this paper argues that studying the deaths of European kings and their close kin is central for an understanding of the global rise of life expectancy, once that rise is seen as a *knowledge driven transition* that began over four centuries ago. Because this claim is likely to seem implausible – if only because it extends the origins of the modern rise in life expectancy so far back in time – more than a perfunctory introduction is required.

Four hundred years ago life expectancy at birth levels in Europe are estimated to have been in the 25 to 35 year range, which, as far as is known, was normal for human populations before c. 1800 (Mesle and Vallin, 2000).[1] Three hundred years later, in 1900, global life expectancy estimates were still in the traditional normal range (i.e. circa 32 years) but by then Europe, at the level of 43-years, was doing substantially better than the world average (Riley 2005: 538). Within Europe, England and Wales already had achieved a higher–than-average life expectancy at birth (47 years, see Coleman and Salt, 1992:39). Within England itself, however, that life expectancy level had been reached and exceeded a century earlier by the members of its ruling families.

In the eighteenth century context, an average life expectancy at birth of 49.4 years gave England's royals more than a ten-year longevity advantage over ordinary people.[2] The fact that the royal family had any advantage at all in this regard was a relatively recent development: in the 1600s the life expectancy at birth of Britain's royals was 24.6 years, a level which put them at a ten year *disadvantage* compared to the level estimated for ordinary English families.[3] Even the seventeenth century British aristocracy seems to have had a higher life expectancy at birth – at circa 32 years (see Hollingsworth, 1977: 328) than the contemporary members of the royal family.

In fact it was only in the course of the eighteenth century that the first signs of the modern pattern "class-specific" mortality differences (favoring higher income groups) began to develop in Europe. (See Antonovsky, 1967; Blum, Houdaille and Lamouche, 1990; Kunitz and Engerman, 1992; Backs, 2001). Once kings and their kin began to live longer than average lives, ordinary families followed their lead, but with a delay[4] that temporarily increased the extent of sub-national social inequality in life expectancy. Today, although

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1 In 18th century France the proto-demographer George-Louis Leclerc, Count of Buffon (1707-1788), already was convinced that all men had, on average, the same length of life between birth and death, irrespective of where they lived, whether in Europe, Asia or Africa. (Blum, Houdaille, Lamouche. 1990).

2 Averages given in the text for Britain's "royals" or "royal families" are equally weighted means of the entries in David, Johansson and Pozzi (2010) – cited hereinafter as DJP (2010), Appendix Tables 2.1b (all royal males) and Table 2.1d (all royal females). The comparison with corresponding long-period means for "ordinary" Britons is based upon estimates for mean life expectancies of males and females (again, equally weighted) in rural villages – as derived by Wrigley et al.(1997) from family reconstitution data. See Figures 2.a and 2.b (below) for further details.

3 These values are based on a simple average of the series of quarter century estimates given for the 1600s in Wrigley and Schofield (1981: p.528) Table A3.l.

4 For England as a whole the demographer T. H. Hollingsworth estimated that by the end of the l8th century the aristocracy's life expectancy at birth had reached a level that it would take another century for the national average to reach. But the catch up process was well under way as early as 1838-54, when the aristocracy's lead

even the poorest Europeans live longer than kings and princes of former epochs, high income Europeans continue to have a substantial longevity advantage over the members of low income families (Soares, 2007:278).

Just as ordinary Europeans once followed the life expectancy lead of economically and socially advantaged Europeans, non-European countries (excluding those colonized by Europeans) began to follow Europe's example in the 1900s (Preston, 1976). Explaining why Europeans led the global transition to higher and higher life expectancy levels has become a scholarly industry; but explaining the earlier, sub-national lead of Europe's own elites has not attracted nearly as much research attention.

The failure to connect these two patterns of demographic change is a direct consequence of the popularity of explanations that blame low life expectancy levels in the past on mass poverty, and, in particular, chronic malnutrition – with an emphasis on caloric insufficiency (McKeown, 1976; Fogel, 2004). In contrast, from the perspective of elite mortality history, it looks as if the primary cause of chronically low life expectancy levels in the past for both rich and poor was chronically high levels of exposure to disease, particularly although not exclusively to the infectious/contagious diseases. That in turn suggests that the fundamental form of scarcity in the past was too little *useful knowledge* about how to prevent, cure or improve the medical management of those diseases that took so many lives before old age, among both the rich and the poor.

In sixteenth and seventeenth century Europe some of the most prevalent and deadly diseases associated with premature death, especially in young adulthood, were bubonic plague, bloody diarrhea, syphilis, malaria, scurvy and smallpox. In the case of these diseases, relative affluence and ample income did not confer upon those stricken any resistance-related advantages that improved their chances of survival; but between 1550 and 1750 various forms of useful, although expensive to implement medical knowledge became available, conferring significantly improved chances of survival upon those who could afford to pay for it. In such circumstances, we would expect to observe that as the stock of useful *but costly* life-saving knowledge increased, so would the extent of sub-national life expectancy differences favoring the richest Europeans.

By implication, the history of the modern rise of life expectancy in the West should begin with the study of elite mortality, and it should focus on the question of what kinds of useful knowledge first became available to the wealthiest sub-populations. Subsequently life expectancy history should track how medically useful knowledge gradually became accessible to ordinary people in Europe, eventually to an extent that was sufficient to begin affecting national level life expectancy trends.

This paper begins by considering the implications of explaining the modern rise of life expectancy as a knowledge-driven health transition, which, viewed from any one of several angles, would constitute a major historiographic break with recent interpretations. Section 2 reviews data on the early rise of life expectancy experienced by Europe's most economically and socially privileged families – its ruling families – from circa 1500 to 1800. Special

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vis-à-vis commoners already had been reduced to 8.0 years (Hollingsworth, 1965:68). Still, elite life expectancy kept rising, so that aristocratic women who were born in 1875-1899 had an expectation of life of 66.7 years. The average woman in England and Wales would attain that life expectancy level about 50 years later.

attention is paid to England/Britain's royal families, because of the exceptionally large gains in life expectancies that were experienced, as can be seen from a systematic analysis of the complete genealogical record for that epoch. In section 3 the accelerating production of useful knowledge in Western Europe after 1500 is reviewed, particularly with respect to the treatment of specific diseases that initially extended adult lives during the 1600s, and the lives of infants and children in the following century, and a connection is established with the advanced medical advice and skills that members of Britain's royal families were in a position to command.

1. Scarcity of Knowledge *versus* Scarcity of Food in Mortality History

Theories that appeal to nutrition (mostly in the form of caloric insufficiency) as the basis for a general explanation for the modern rise of life expectancy, have long been criticized by demographic historians and some demographers as inadequate biologically, chronologically and even statistically (see Preston, 1976; Fridlizius, 1984; Livi-Bacci, 1991; Johansson, 1994). As that line of criticism became elaborated, knowledge-based explanations for the *modern* rise of life expectancy have gained greater acceptance (Preston and Haines, 1991; Chesnais, 1992; Easterlin, 2004; Soares, 2007).

Generally, the knowledge in question is identified as coming from the application of germ theory to public health measures; but since germ theory had its domestic side, useful knowledge could also be applied at the household level, particularly through measures designed to improve standards of cleanliness (Mokyr, 2002; Riley 2005).

In 1992 the French demographer Jean-Claude Chesnais used the global demographic transition itself as another example of how the diffusion of knowledge that initially gives rise to new models of behavior "within privileged milieux," gradually becomes available to ordinary people (Chenais, 1992: p. 364). For Chenais the marked life expectancy inequality between countries still existing today is inherent in the "very nature of medical progress" (p.47), meaning that the wealthiest countries were and would continue to be the first to benefit from the development of new and effective methods of disease control, whereas those countries too poor to afford the latest innovations would lag behind in terms of life expectancy levels.

But Chesnais (p.75) also maintains the now traditional view that the "first real medical revolution" began in the *late 1800s* with the germ theory of disease first verified by the research of Pasteur and Koch. Thus he had no reason to extend his reasoning to earlier centuries, and consider what it might imply in regard to the differential mortality experience of Europe's economically and socially privileged elites. Historians would have given him no reason to venture in that direction, because most prefer to see the modern rise of life expectancy as a complex process in which different causes operated in different (national) cases (e.g., Riley, 2001). Even in public health history, where standardized health reforms eventually came to be adopted everywhere, highly variable local political considerations influenced the timing of their introduction and the extent of their deployment (Szreter, 1988). From a narrowly statistical standpoint, localized timing irregularities make the influence of national public health reforms on national mortality trends appear quite arbitrary (Cutler and Miller, 2005: 5). Furthermore, if even we had micro-level data about household behaviors, it is quite possible for the temporal and spatial patterns in the adoption of domestic hygienic practices to be so complex that they defeat attempts at simple generalizations about national or still broader regional trends.

Knowledge-based explanations for the modern rise in life expectancy work best when they are brought to bear upon the empirical data *not at the national level,* but in specific contexts where the research focus is on the control of specific diseases in specific social and economic environments. It is only in theory that the force of knowledge can be said to drive death rates down and life expectancy levels up, nationally or globally. Real lives are never saved by abstract concepts like "knowledge"; nor are death rates reduced by increases in vaguely

related variables like literacy as a proxy for access to knowledge. It is specific forms of knowledge, successfully applied in specific times and places that save lives from the various causes of premature death. For historical research the implication is: the more sub-national heterogeneity there was with respect to the actual delivery of useful knowledge to communities and households, the less useful national level life expectancy data becomes for purposes of explaining what is "observed" in national level data.

In contrast, when the modern rise of life expectancy is explained by appealing to improved nutrition, particularly in the form of less chronic and/or less sporadic caloric insufficiency (Fogel, 2004) one locality is as good as any other for explanatory purposes; therefore nothing is lost by using national level data to observe mortality change. If during the long pre-transition era the average person (of no particular age, gender or location) was chronically malnourished, then what the average adult needed, always and everywhere, was more food, or more money to buy it and, presumably share it with their younger/older dependents. Biologically this assumes that improved nutrition alone was sufficient to have dramatically increased the average person's level of resistance to "disease" irrespective of pronounced biological differences between the specific diseases to which they were exposed in the diverse disease environments in which they lived. In every, case national or local, it becomes the interaction between food and physiology that determines the average length of life.

Such simplifying assumptions conveniently overlook that specific diseases are differentially sensitive to the nutritional status of their hosts. (Livi-Bacci. 1991; Scott and Duncan, 2002).[5] For example, a sufficiently high dose of exposure to the pathogens causing smallpox or malaria – to say nothing of bubonic plague – readily can translate into sickness and death irrespective of the adequacy of the individual's previous diet. Since exposure patterns were geographically variable, disease-specific death rates varied from place to place for reasons independent of nutritional status or poverty, even in the case of the most nutritionally sensitive diseases (Johansson and Mosk, 1987). In the past, there were some relatively epidemic-free localities, where even the rural poor could live longer on average than the highly exposed, urban rich. Today there is solid demographic evidence that life expectancy can rise, even in countries where the nutritional status of many children is declining (e.g., Soares, 2007: p.270).

Finally, when the focus of attention is exclusively on the average, *representative* person in the past, who is seen to have been chronically malnourished, it seems only reasonable to ignore the mortality history of wealthy and perennially well-fed sub-populations – on the grounds that such groups obviously were too atypical to explain what happened to ordinary people.

Despite the shortcomings of what amounts to a form of "nutritional reductionism," this approach remains popular with social scientists for both practical and theoretical reasons. As a practical matter, a simplified theory of the global transition to higher life expectancy levels has been appealing in making it easier for contemporary demographers to give policy advice. In contrast, reading a stack of sub-national studies (historical or anthropological) that

[5] Scott and Duncan (2002: p.280) provide a list of diseases normally classified as having little ("slight") or no relationship to nutritional status. Their list includes typhoid, bubonic plague, tetanus, bacterial toxins, smallpox, yellow fever, encephalitis and malaria.

emphasize how different each locality is from every other one makes the business of generalizing for practical purposes more difficult, if not impossible (Steinmetz, 2005). Moreover, from a theoretical standpoint the traditional positivist dream has been to reduce superficial social complexity to its underlying simplicity, preferably in the form of a law-like equation. This aspiration has long driven demography to gravitate towards narrowly quantitative methods that rely on the relative abundance of national level data, instead of relatively scarce and often un-standardized data that comes from diverse, sub-national contexts and can only be explained in context (Riley and McCarthy, 2003:39; Szreter, Sholkamy and Dharmalingam, 2000).

But perhaps the most important advantage of nutritional reductionism remains emotional (Johansson, 2005). Its most influential proponents have capitalized on a natural sympathy for the victims of hunger by giving readers a quasi-mythological vision of human history in which our ancestors – who for time out of mind supposedly lived on the verge of starvation – finally and happily escaped from dire poverty to lead longer, healthier lives in the triumphant present (see, e.g., Fogel, 2004). In contrast, emphasizing the importance of producing useful knowledge does not stir deep emotions.

If ignorance, not hunger, is the villain of mortality history, by implication its heroes must be those innovative producers of disease-related knowledge, most of whom had a medical background. From an historical perspective this is problematic, because most of those individuals who lived in early modern Europe, and who were in a position to produce or legitimize and deliver useful disease-specific knowledge, were "medics" in one form or another. Furthermore, the individuals who treated members of the elite themselves belonged to an exceptional elite minority of physicians and surgeons. Current day historians of medicine, however, remain very skeptical about the existence of practical medical progress before the twentieth century, doubting as to whether much useful knowledge could have become available to anyone, poor or rich, several centuries earlier.

Nevertheless, as will be seen (in section 2) a substantial body of evidence can be marshaled to support the view that a growing corpus of useful medical knowledge was produced in Europe from the sixteenth century onwards. That this evidence has been neglected by many modern medical historians is surprising, but it could simply reflect their appreciation of the very fact that makes its existence germane in the context of the present argument –namely that the social sphere within which that knowledge could find practical application at the time was very tightly circumscribed. Only the wealthy elites were in a position to command the services of those with access to the latest medical knowledge, and during the pre-transition era that group constituted a very small proportion – never exceeding 2 percent – among Europe's national populations. Thus, just as the early mortality transition among the elites has been lost from view when national level statistical evidence is exclusively made the basis for writing mortality history, so too, the clues to the knowledge-driven nature of that transition have been pushed aside as irrelevant to the circumstances of the mass of the population.

Section 2 of this paper examines the available quantitative data tracing the history of changes in mortality rates among the elites from c. 1600 to c.1800, tracing the detailed pattern of leads and lags in the movement of life expectancy level differences between the rich and the ordinary people of Western Europe. In this epoch the richest and highest status

members of the population were its royal families, and they were the first Europeans to be "medicalized." But, more than simply being treated regularly and frequently by professional doctors, they were attended to by those who were (supposedly) the most informed and skilled among the available physicians and surgeons, and not by ordinary physicians from the ranks of the less formally educated, or the less well-trained barber-surgeons.

Virtually as a matter of definition, transitions in the life expectancies of elites cannot be identified without engaging in small scale research studies of "exceptional" populations, groups whose material circumstances were far removed from those of the mass of their contemporaries. Social science historians have provided formal justifications for doing this kind of non-standard social science research (Graff, Moch and McMichael, 2005), which has proved to be especially informative in exposing the origins of local changes that eventually transform the way an entire social system works (see, e.g., Greif, 2006) . Unfortunately, too many modern demographers continue to regard historical research as marginal to mainstream research in their discipline, and the more that historical inquiry focuses upon the experience of exceptional populations, the more marginal it is perceived to be.

When John Caldwell introduced the concept of "health transition" to demographers in 1992, he wanted to persuade them to observe how the living managed to stay alive by taking whatever means and measures they could to preserve or restore their health in particular disease environments where qualitative, procedural, knowledge typically was just as important, if not more important, than analytical and quantitative scientific understanding.

Ironically, Caldwell's innovative new concept was enthusiastically taken up, but only as a fashionable new name for both the old "mortality transition" and the more recent "modern rise of life expectancy." The mere name change effected no new methodological departures, however, since the mainstream research agenda on mortality trends continued to be dominated by the traditional priority accorded to efforts to statistically account for such "transition" leads and lags that could be seen from comparisons of national level data. That approach devalues research which seeks to identify the sub-national level leads and lags among income groups (or "social classes") within given societies and regions, or among members of the same general social stratum that – whether for one reason or another, or simply because they were not fully informed of the likely consequences – persistently dwelt in markedly different disease environments.

To uncover the ways in which demographic transitions can reflect the processes through which specific forms of knowledge are discovered, legitimized, and translated into practical courses of health-improving and mortality-deferring action, it is necessary to take account of the diversity of the human condition within, as well as between, societies at a given historical moment, and of the evolving pattern. Those inhomogeneities affecting both behaviors and health outcomes. By pursuing research programs of this sort one may hope to escape the "blinkering" effect of setting out to explain the statistically constructed experience of a fictive individual or household whose experiences are held to representative of those of the population as a whole.

2. European Historical Demography and Britain's Royal Families

When historical population studies became a distinct sub-field of demography after World War II (Rosenthal, 2003), one of its first achievements was recovering enough data to estimate life expectancy levels in the past, for both elite and ordinary Europeans. Although the elites always were regarded as highly atypical subjects of study by "demographic science," the fact that their genealogical records of births, deaths and marriages extended back so far in time, and in an exceptionally complete and accurate form, was a sufficient justification for them to receive the attention of quantitative researchers.

As part of the first wave of historical demographic research, Sigmund Peller used published genealogical information on Europe's ruling families to extract standard demographic data on their mortality history.[6] Table l summarizes Peller's (1965) conclusions with respect to royal life expectancy levels in Europe over three and a half centuries.

For centuries preceding 1700, the data assembled by Peller (1965) revealed that Europe's wealthiest and most socially advantaged families had surprisingly low levels of life expectancy, levels that were very much the same as those of the European peasantry. But between the 1600s and the early 1800s, royal life expectancy levels rose by about 18 years for males, and 14 years for females. This substantial increase occurred well in advance of any equally marked life expectancy increases for ordinary people, as has been revealed by subsequent estimates for the latter, derived from family reconstitution studies based on parish registers and other sources.

Continuing historical research showed that there were other elites in Western Europe who had also began a transition to higher levels of life expectancy at birth at various times in the 1600s (Antonovsky, 1967; Blum, Houdaille and Lamouche, 1990).[7] In general, it became clear that the early rise of life expectancy among Europe's ruling families was simply one case of a general surprisingly early rise in life expectancy among Europe's economically and socially privileged elites.

Peller's data for Europe's royal families exhibited the following patterns: a) adults born in the 1600s showed the earliest life expectancy increases, a trend that included older people who were already over 50 and 70 years of age; b) for a century or more, adult royal men added more years to their average lifespan than adult royal women; c) life expectancy *at birth* for ruling families rose most rapidly in the 1700s when death rates among their infants and children began to decrease. Royal infant mortality rates fell from a recorded high of 246 per thousand (unadjusted) in the 1600s, to 153 per thousand in the 1700s, and 96 per thousand during 1800-50.

Because Europe's royal males seemed to have had an early mortality advantage vis-à-vis royal females, Peller took a closer look at the influence of possible changes in the incidence of violent deaths on the overall level of male mortality rates, extending this inquiry far back

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[6] Peller's work was based on the genealogies compiled by W. H. Isenburg (1936-7).

[7] The elite groups studied to date include the Dukes of Milan, the Geneva Bourgeoisie, Dutch Annuitants, British Tontines, British aristocrats, British MPs, French Tontines, French Monks, and Europe's ruling families, among others, and are discussed by Blum, Houdaille and Lamouche (1990). In Italy some urban elites took an early lead, only to falter later (see Zanetti, 1972).

into the medieval era. He found that between 1100 and 1299 about 6 percent of the males in royal families who survived to 15 years of age subsequently met violent ends.[8] Between 1300 and 1499 only four per cent of royal males died violently; and after 1500, violent death among royal males was so infrequent that further reductions could not account for the early rise in life expectancy of adult males born to Europe's ruling families, or their advantage in comparison with royal women.

Table 1.Europe's Ruling Families: Life Expectancy at Ages 0, 15, 50 and 70 Birth Cohorts 1500-1850 for Males/Females

Birth Cohort	Average Remaining Life Span at Age:			
	0	**15**	**50**	**70**
1500-99	32/36	31/35	14/15	4.9/6.8
1600-99	28/34	30/36	15/16	6.5/7.2
1700-99	36/38	40/40	18/18	6.9/7.7
1800-49	46/48	43/45	19/22	7.4/10.4

Source: S. Peller (1965) *Population in History*, Table 10, p. 98. Peller's data set contains 2,888 adult males belonging to Europe's ruling families, who were born between 1500 and 1850. When their wives and legitimate children were included, the data set contained some 8,500 individuals. Peller's life expectancy estimates are based on averaging the ages at death of the members of his birth cohorts. But those women who lacked accurate death dates appear to have been omitted from his calculations. Before circa 1700 this meant deleting about 20 per cent of Europe's royal women. Since Peller doubted that every royal infant birth/death had been fully recorded before circa 1600 (p. 87) he also suggested that the slight decline of royal life expectancy *at birth* in the 1600s might have been due in some part to an apparent rise in infant mortality. That would make the decline a side-effect of more accurate royal birth recording. None of Peller's published articles lists which royal families he included in his data set. But it could have only contained the thousands of individuals it did, because German ruling families were included. Until the mid-nineteenth century Germany was divided into dozens of small kingdoms and principalities, each with its own ruling family. In contrast, large countries like England, France, Sweden, Russia, Spain and Portugal are represented by only one ruling family at any one time. Hence Peller's data set is biased towards the ruling families of smaller scale principalities in Germany, and nothing is known about how this affects the averages calculated.

8 As a category "violent death" normally includes murder, accidents and suicides. The French demographer, Jacques Houdaille (1972), concluded from his examination of data for medieval ruling families that preceding c.1500 their male members had an even lower life expectancy at birth (c. 25 years) than the 30 or so year they experienced after 1500. Part of this early rise in life expectancy was due to a decline in the relative frequency of violent deaths before 1500, and not after that date.

Peller was not able to explain the life expectancy trends he observed, and, similarly, those who came after him have simply noted the fact that it was Europe's wealthiest elites and not the common people that had led the transition to higher levels of life expectancy (Livi Bacci, 1991; Riley, 2001, 143). One of the reasons why global human life expectancy history remains so controversial a matter even today would seem to be the abandonment of efforts to account for the early decline in mortality among Europe's elites, and its distinctive age- and sex-linked pattern of changes (Hill, 1995; Soares, 2007). The one issue that attracted substantial research attention from modern demographers was the approximate parity between mortality rates that had existed between princes and peasants before c. 1700. This apparent equality was very much in contrast with what is observed in contemporary mortality data, in which economically and socially privileged groups invariably live longer than average, while the lowest income groups live the shortest lives of all.[9]

Historians attributed pre-modern mortality equality to the fact that pre-modern disease environments were dominated by epidemic diseases that, like smallpox, were equally deadly to all the exposed. But even this very partial explanation was imperfect in that it ignored the special health disadvantages incurred by Europe's elites after 1500 due to their preferences to reside for all or major parts of the year in large urban centers – which exposed them to the vectors of pernicious and often fatal diseases – whereas most of Europe's population at the time remained in safer, rural environments.

One the eve of modern public health reforms, urbanized Europeans still experienced substantially shorter average expectations of life at birth than country-dwelling folk (Kearns, 1991). This appears to have been the experience of Rome's rulers one thousand years earlier (Scheidel, 1999: p. 280). But there was considerable local variation, and average urban life expectancy could fall below that of the general population – depending upon the specific circumstance of time and geographical locale (Mosk and Johansson, 1986).

It was only when some historical demographers began to sub-divide Europe's urban populations into social classes/income groups, that what is regarded today as "normal" became recognized as normal also for the past – i.e., well before the modern rise of life expectancy, the urban rich already held a longevity advantage over ordinary urban families and, of course the urban poor (Perrenoud, 1985; Weir, 1995; Bourdelais, 2003). Inequalities in urban life expectancies clearly co-existed with the rough parity of mortality rates between (urban) princes and (rural) peasants.

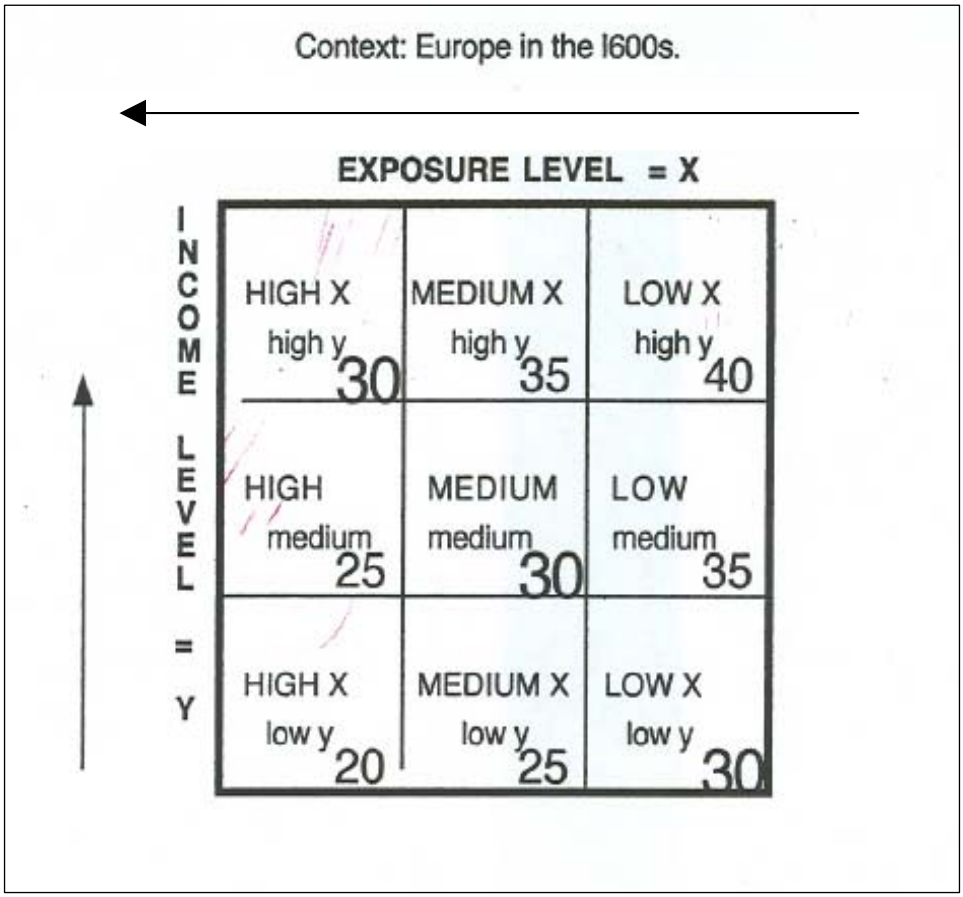
To clarify what is by now a complicated, and in some respects confusing body of historical research, we can model a hypothetical, pre-transition national population by dividing it into several sub-national populations that are differentiated according to (l) the groups' relative income level (to weakly proxy for their average levels of resistance to life-shortening diseases); (2) the relative degree of the representative group member's exposure to the disease-causing pathogens, as a consequence of the environment in which they habitually dwell. Partitioning the entire population of the region, or nation into high, medium and low

[9] See Pritchitt and Summers (1996); Machenbach et. al., (1997). Currently in the United States standardized death rates for individuals under 65 years of age can be twice as high for those who live in the highest income census tracts versus those who live in the lowest income. (Drexler, 2006). In Britain and Australia recent research suggests similar conclusions (see Turrell and Mathers, 2000).

income groups, and high, medium and low disease-exposure groups ('high exposure" being associated with high-density urban residence, and "low exposure" with low density rural residence), this schema creates a "mortality matrix" with nine cells – as is shown in Figure 1.

Figure 1. The Mortality Matrix:

Levels of Life Expectancy at Birth (in years),
as a Function of Household Income per Capita (**Y**) and
Severity of Exposure to Disease in the Local Environment (**X**)



Notes: Reading diagonally from the upper left to the lower right cell yields 'mortality parity between princes and paupers,' i.e., between urban elites and rural peasants, because the income level varies positively with the severity of exposure to disease. Reading upwards in any column holds the disease environment constant, and yields the expected positive association between income and life expectancy at birth. Comparison of the e_0 levels within any row shows the rural-urban differentials in survival rates.

For heuristic purposes we may suppose that the region's representative person or family would be "observed" in the matrix's middle cell–having the average income and environmental exposure levels. In the European pre-transition context this would correspond to residing in a fairly small village in a predominantly rural area. Whether or not the average income would give this average person more than a subsistence standard of living would depend, of course, on the specifics of the society's production potential and the extent to which that potential could be realized under the particular historical circumstances – affected

as those may be by political disruptions and climatic changes. Most historical research focused on the 1500s and 1600s indicates that the situation of the *average* pre-transition Western European would imply having a life expectancy at birth of approximately 30 years.

Reading the mortality matrix diagonally from upper left to lower right reproduces the surprising observation of parity in expected life-spans among the urban princes and the rural poor that was uncovered by the work of Peller and other demographic historians. But this apparent equality is seen to be to be an artifact of the hypothesized positive association (correlation) between income levels and exposure to disease, which one finds when moving *along the principal diagonal* of the matrix and noticing that the effects of the changing levels of income and disease exposure on life expectancy are working to offset each other. Holding the disease environment constant, which is done by *reading down any one column*, it is found that higher income groups do have an expected longevity advantage vis-à-vis the sub-populations at the middle- and low-income levels, both in the urban and in the rural disease environments.

The illustrative values entered for life expectancy at birth (e_0) in the cells of Figure 1 are specific to Europe in the 1600s; they imply that in a large seventeenth century city the richest families' average span of life exceeded that of the families at lower income levels, being as much as a third longer than the average found among the poorest urban families. Fixing the historical context in both time and place in this way serves as an obvious warrant for the tacit assumption that the state of effective medical knowledge in the society was not changing perceptibly within the time interval to which those life expectancy durations relate. But there is a further, implicit supposition in the schema presented – namely, that for each subpopulation the representative individuals' access to the best of the available medical attention and advice (on that state of knowledge) would vary directly with the level of real income.

Thus, in any particular disease-exposure environment, increasing the absolute and relative levels of real income could work to raise mean life expectancies for the sub-populations representing national or regional averages, and the below-average levels –due to its effects both on nutritionally related resistance and access to better medical treatment. But there would be no comparable effect of income growth in the case of the wealthy elites, as further enrichment of their material circumstances would not translate into either significantly enhanced nutritional status or better medical attention – given the constraint placed on "best practice" by the existing state of medical knowledge. Only by increasing the stock of useful knowledge would it be possible to raise the context-specific ceiling on the quality of medical care to which the resources of the richest and privileged families would have given them access. Therefore, if a knowledge-driven transition to longer life expectancies were taking place, we should expect to observe its impacts most clearly among the elite stratum of the society.

Although the illustrative values appearing in Figure 1 for life expectations at birth are empirically based, the actual historical data show that there were temporal and as well as geographical variations around these epochal averages for Western Europe in the seventeenth century and before. Real world values vary over a wider range. This static table abstracts from the realities of a dynamic disease environment, which saw Europe become colder (during its "Little Ice Age"), and wracked by internal warfare in the power struggles between

Catholic and Protestant factions. The movement of armies contributed to both the disruption of food supplies and the outbreak of severe epidemics that, when abetted by local famines, brought death to large numbers of the population at the lower end of the income distribution. In view of these conditions, it is not surprising that demographic historians have found data indicating that for ordinary Europeans, even adults, the level of life expectancy was falling somewhat during the late 1600s and early 1700s. The elites, however, seem to have escaped this adverse trend, as might be expected if the source of the setback was diminished and disrupted food supplies and greater exposure to severe cold weather.

With respect to Peller's entire assembly of European ruling families, nothing is known about the extent of differences in life expectancy among them, either before or after their average ages at death began to rise. All ruling families were wealthy, but some ruled smaller kingdoms and lived in smaller cities than others. By c. 1500 England's ruling family spent much of its time living in or near London, a city that grew rapidly and by 1700 had become one of Europe's largest, dirtiest, most polluted and epidemic-ridden places. Living in or near London would have imposed a mortality penalty on even the richest families. But by c. 1700 London also had become the leading center in Europe for innovative medicine and surgical practices, and England's ruling family had unimpeded access to what was then regarded as the best medical care that could be offered.

Life expectancy data for the ruling family of England/Britain can be extracted from the exceptionally detailed royal genealogy compiled by Alison Weir.[11] In England, with a few exceptions, age at birth/death data for kings and princes was complete and, in most cases accurate to the day by c. 1550. The data for queens and princesses was almost as exact, but among the women who married into Britain's royal families, and who were not royal by birth there were some whose exact date of birth remained obscure even in the post-1550 cohorts.[13] Remarkably, it appears from the genealogical data that all royal infants' birth/deaths in England's ruling families were recorded (most to the exact day) from the 1500s onwards – not omitting those that were stillborn.[14]

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[11] Over several decades Weir (1996, rev.ed.) has periodically revised and expanded her genealogical data base, so that it now includes what is known about royal mistresses and their illegitimate children. In England the birth and death dates of royal males were known with a high degree of exactness from the late middle ages, while birth or death dates for some royal females remained uncertain. But after 1500 those females born to England's royal family also had exact birth/death/marriage dates, although not all women marrying into the royal family did. Royal infant deaths must have been fully recorded after 1500 as well, if only because there were so many of them! Moreover, after 1500 royal live births were being carefully distinguished from royal stillbirths. Weir was even able to include some data on royal miscarriages, which, presumably (see Hatcher, 1986), were observed by contemporaries after the first trimester.

[13] Although the following text refers to "Britain's" royals, this label applies strictly only for the period following the Act of Union (1603) with Scotland. For the sake of greater temporal comparability, the data studied here pertain to England's royal families during the long sixteenth century (1 January 1485 to 31 December 1606, thereby including all the children born to Henry VIII). Omitting the Scottish royal families in the 1500s has the desireable effect of maintaining greater constistency in the geographical setting of the royal households to which the time series examined here pertain.

[14] Peter Razzell (1999) also used Weir's (1996) genealogical data to calculate royal life expectancy, but he combined data for the English and Scottish royal families. In the 1500s, the Scottish royal family had much higher infant and adult mortality than their English counterparts, with the result that Razzell (1999: p. 7) gives the combined English/Scottish royal family a life expectancy at birth of 15.2 years for the 1500s and 1600s. That compares with the average of 24.8 for England's royal males and females combined (as seen from DFP 2010, Appendix Tables A1.2b, and 2d, Cohort 0).

When the definition of Britain's "royal families" is restricted to include only kings, queens and the legitimate births to formal marriages, the resulting population is quite small. A detailed study of the data extracted from Weir (1996 rev.ed) is presented in DJP (2010), Table A.1.1 of the Statistical Appendix shows the counts of all the royal males, and the females, separately, when the genealogical entries are used to form overlapping century-long birth cohorts.[15] In all, the dataset provides observations on the age at death for only 49 males and 52 females born between the end of the 15th and the 18th centuries. The eighteen males and twenty-five females that had been born into, or married into Britain's ruling family had average life expectancies at birth of 29.9 and 23.0 years, respectively. This was already a slightly higher mean age at death than Peller (see Table 1) found for the men in Europe's (mostly continental) ruling families; but the mean age of death among the female royals in Britain was 11 years below that of the corresponding Europe-wide figure.

Bearing in mind the male-female differences in age-specific mortality rate and the resultant expectations of life at birth, and at subsequent points in the life cycle, it is nevertheless useful to form an initial overall view of the British royal families' early mortality transition from Table 2, where the birth cohort averages of mean life expectations are presented for the male and female royals taken together. These appear in the left-most panels, which shows the estimated expectations at birth (e_0), and at age 25 (e_{25}) for each of the five royal birth cohorts, together with the number of observations from which these have been calculated. In the central panel of Table 2 corresponding estimates are given for 26 English parishes studied by Wrigley et al. (1997).[16]

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[15] See DJP (2010) Table A.1.1 of the Statistical Appendix. The century-long duration of these cohorts therefore facilitates comparisons with the cohort expectation of life statistics presented in Table 1, based on Peller's data, and affords sufficiently large sample densities to keep the variances of ages at death reasonably small in relation to the respective cohort means. See the Notes to DJS (2010) Table A.1.1 and the accompanying text for the rationale of the two deviations from exact 100 year spans in the delimitation of these birth cohorts. In the case of Cohort 0 the actual span is 1485-1606, rather than 1500-1599; correspondingly, in Cohort III the span is 16o6-1699 and not 1600-1699. These departures from the nominal designation of the birth cohorts "1500-1599", and "1600-1699" are taken into account in calculating the mean death dates reported for these cohorts in DJS (2010) Appendix Tables A1.2 (a, b, c, d). The latter have been used to plot values of the cohorts' mean ages at death in Figures 2 (a, b, c, d), below..

[16] The underlying decennial averages of *e* are given for males and females combined (M+F) by Wrigley, Davies, Oppen and Schofield (1997), Table 6.21 (p.290); corresponding estimates of e_{25} are given in Table 6.19, for 1640-49 onwards. The series is extended to earlier dates using the decade average values graphed in Figure 6.15 (*Ibid.*, p. 283) for 1600-09 through 1630-39. Consult the text of Statistical Appendix A3, Tables A3.1and A3.2 for the methods used to fix the time intervals over which underlying birth cohort and period estimates of e_0 , and also the decadal e_{25} observations, were averaged to form estimates that were approximately comparable with those presented for the century–long birth cohorts of royal family members (M+F). As is noted in Appendix A3, achieving strict comparability between cohort and period estimates of life expectations poses a considerable technical challenge for demographers.

Table 2. Expectation of Life at Birth and at Age 25 for Royal Cohorts: Males and Females Combined Compared with Reconstituted English Parishes and England's National Population

Royal Birth Cohorts	Royal Families				26 English Parishes (derived from Wrigley et al. (1997)		National Population of England
	Average Expectation of Life at Birth: M and F		Average Expectation of Life at Age 25: M and F		Expectation of Life at Birth: M and F	Expectation of Life at Age 25: M and F	Expectation of Life at Birth: M and F
	No. Obs.	e_0	No. Obs.	e_{25}	e_0	e_{25}	e_0
1500-1599	31	25.3	12	24.8	n.a	n.a.	34.6
1550-1649	22	30.1	11	25.1	38.8	22.2	36.9
1600-1699	43	25.9	18	30.3	36.1	35.5	33.8
1650-1749	44	32.4	14	33.8	35.8	32.6	35.9
1700-1799	37	49.5	16	34.6	40.8	35.9	37.0

Source: See DJP (2010), Statistical Appendix A2 and Table A3.2

Also shown, in the column on the right, are roughly comparable estimates of the expectation of life at birth for males and females in England's national population.[17]

The comparisons afforded by Table 2 therefore serve nicely to reveal the broad quantitative outlines of the transformation that was taking place during the late 17th and 18th centuries in the relationship between the mortality experience of Britain's urban dwelling royal families and the population of the country at large. In the birth cohorts of the epoch stretching from the end of the fifteenth century through the end of the seventeenth century the royals' mortality disadvantage *vis-à-vis* the national population varied between 7 and 9 years difference in the expectation of life at birth.[18] It would appear that during 1550-1649 the gap vis-à-vis rural villagers in England was even wider than that– by at least 2 additional years. This may be seen from the difference between the average levels of e_0 for the royal males and females in the predominantly although not exclusively rural group of English parishes studied by Wrigley et al (1997).[19] The prevailing contrast between the mortality situation of royalty and that of the mass of the population – characterized by vastly different material income levels but also situated in markedly different environments in terms of their exposure to disease, had thus been substantially worse than the classic notion of "pre-modern parity between princes and paupers" depicted by the heuristic "mortality matrix" in Figure 1.

What is noteworthy in Table 2 is the improvement in both the absolute and relative survival rates experienced by members of the royal families belonging to the 1650-1749 birth cohort, resulting in a 5.3 year gain in their average expectation of life at birth above the level of e_0 that had prevailed among those born during 1500-1650. The movement of e_0 from the

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[17] See the notes and sources for DJS (2010): Statistical Appendix Table A3.1 for the derivation of how the "national population" entries in Table 2 were obtained – briefly, by forming weighted averages of the quinquennial values of e_0 based on *period* life table estimates obtain from Wrigley et al. (1997: Appendix 9, Table A9.1). The latter were derived (from aggregative birth and death time series for some 400 parishes in England) by application of the method of generalized inverse projection, and represent a revision of the earlier "back projection" estimates presented by Wrigley and Schofield (1981). The problem of translating period measures of life expectation into cohort measures is technically challenging. As Appendix A2 acknowledges in DJP (2010), the procedure that has been adopted in constructing Table A3.1 (and hence the national population entries e_0 averages in Table 2 for intervals corresponding to the royal birth cohort averages) is *ad hoc* and inexact. But, inasmuch as the averaging intervals are long and the underlying time series of quinquennial period e_0 series exhibits neither pronounced short-run volatility, nor strong secular movements prior to the 1760s, inaccuracies in the intervals defined for averaging are unlikely to result in serious non-comparabilities that could vitiate their usefulness in the context Table 2's comparisons with e_0 averages based on birth cohort data for the royal families and the reconstituted English parishes.

[18] An earlier set of e_0 estimates was obtained by Wrigley and Schofield (1981) for England's national population by "back projection" – which made use of the structure of mortality indicated by the earliest of the (then) available life tables for England and Wales (1841). This produced estimates of average life expectancy at birth for ordinary English people during the latter half of the 1700s that bracket the recent family reconstitution-based estimates (40/41 years, females and males, respectively) for that period: the lower of the pair is 34/36 years, whereas the higher value is given as 45 years (see Wrigley and Schofield (1981), p. 252: Table 7.24.

[19] Of course, this difference mirrors the 2 year gap (roughly, 38 *vs.* 36 years) separating average e_0 in the 26 parish sample from the estimated average for England's national population. As a whole, those families whose demographic event histories could be reconstituted for study by the Cambridge Population Group led by A. E. Wrigley are a selective sample of their respective parish populations, in that they lived all or most of their lives in one parish. See Wrigley et al. (1997), Ch. 3 on "representativeness" of the reconstituted parish population. Their Table 6.27, *(Ibid*. p. 308) presents e_0 for males' and females' separately, each averaged over 25-year intervals starting in 1625, and the notes to Figures 2 (a and b) described how these have been plotted for comparability with the averages based on the means of ages at death for the birth cohorts of royal males and females.

neighborhood of 25 years to a level somewhat above 30 years brought the mortality experience of royal adults closer to parity with that of the predominantly rural parish population, reducing the average gap between them to only 3.5 years.

This is all the more remarkable in view of the very substantial portion of the year that members of the royal families were residing in or near the disease-ridden environs of London, and hence living in close quarters with servants who were not isolated from direct contact with tradesmen, footmen, servants of other elite households, not to mention their own families and friends in the metropolis. During the seventeenth century the average expectation of life at birth in a sample of London's parishes is estimated to have been 20 years or less (Landers, 1990).[20] Which would imply that the average e_0 of royal males and females in the birth cohort of 1600-1699 (at 26.4 years) already gave them at least a six year longevity advantage in comparison with London's commoners.

The differentially larger improvements of the elites' expectations of life continued into the next century, so that among those forming the royal birth cohort of 1700-1799, the average age at death (males and females combined) exceeded that of the mostly rural parish-dwelling population by 8.7 years, and surpassed that of the (somewhat more urban) national population by as much 12.5 years. It should be appreciated that these relative gains in the royals' longevity emerged even though the expectation of life at birth in the country at large also increased between comparable periods in the seventeenth and the eighteenth centuries.

Whereas the gains in e_0 for the royals vis-à-vis commoners in the 26 reconstituted parishes were remarkably large, that was not the case for the adults: men and women in those parishes enjoyed slightly bigger absolute gains in longevity, so that when they reached age 25 they too could expect to live another 36 years – actually about one and a half years longer than their palace-dwelling counterparts. Consequently, a third point to be remarked upon in Table 2 concerns the proximate source of the impressive absolute and relative gains that took place in the expectation of life at birth among the royal families born during the eighteenth century, and particularly during its second half. In contrast with previous improvements in their longevity, these gains largely reflected the increased likelihood of their surviving to age 25: the gain of 17 years that was recorded in average e_0 between the royal birth cohort of 1650-1749 and that of 1700-1799, was accompanied by less than a full year increase in $e_{25.}$

Comparisons between royal and ordinary adults of both sexes such as those that have just been made are complicated by the fact that populations of the 26 reconstituted parishes –- here representing, for the most part, the ordinary people of England's country villages and small towns – were not homogeneous economically, geographically, or with respect to their local disease environments. A few of the reconstituted parishes that are described as urban had higher than average death rates.[21] The healthiest (longest-lived) ordinary people seem to have lived in the most remote parishes. In those exceptionally sheltered locations some ordinary families may have continued to live longer on average than the royal family, even in

[20] In London recorded infant baptisms/burials translate to an infant mortality rate of about 300/1000. Since there was extensive under-registration of illegitimate births and births quickly followed by death, the real infant mortality rate in London must have been substantially higher. (Razzell, 1999). In rural areas, infant mortality rates were about half the unadjusted London average.

[21] For further details, drawn from material in Wrigley et al (1997), see the notes to Table 4, below and the accompanying text discussion.

the 1700s. In the higher density parishes however, where rural industry was developing rapidly, ordinary people probably fell more and more behind the ruling family, just as was the case for their London counterparts. To the extent that these environmental inhomogeneities had their primary impact upon the survival of infants and children, the differences observed between the mortality trends among adult royals and commoners are less ambiguous in their import.[22]

Estimates of the *life expectancy at birth* of males, and of females dwelling (mainly) in rural parishes are available as twenty-five year averages after the first quarter of the seventeenth century, and these have been graphed in Figure 2(a) where they are juxtaposed with the corresponding estimates for the royal males that were just discussed.[23] The comparisons reveals how striking was the transformation in differential mortality that took place between the end of the sixteenth and the end of the eighteen century: during 1600s England's (urbanized) royal males' lives were about 7 years *shorter* than the average 37 year span of male commoners, whereas a century later the royals could expect to enjoy an 8 year advantage in longevity. Royal females born in the 1600s had a life expectancy of birth of only 23 years, while ordinary females from predominantly rural families are estimated to have had a life expectancy at birth that averaged 36.4 years, indicating a royal longevity *disadvantage* of about 13 years – almost twice as great as that which existed among males! In the latter half of the 1700s, by which time royal life expectancy at birth for royal women had risen to average 51 years, these women had acquired more than a 10 year advantage *vis-à-vis* females commoners dwelling in the largely rural parishes.

The picture that emerges from comparisons of life expectancy levels for those adults who survived to age 25 suggests that something closer to the classic "princes/peasants" parity in mortality (depicted in Figure 1) had come to exist among mature adults in England early in the seventeenth century. That was the case at least for the royal males in the birth cohort of 1550-1649 who survived to age 25, as their mean age at death was 57.4 which put them at approximate parity with their adult counterparts in the predominantly rural parishes. But, the comparison just made, between adult male survival rates and the survival rates for men and women taken together in the population at large, implicitly raises the question of whether the rural men were outliving women in these parishes. This is a matter that, unfortunately, cannot be definitively resolved, yet deserves some consideration, and is discussed further in section 4.

Further light is thrown on the quantitative dimensions and timing of this early mortality transition by following the course of changes in life expectancy among males separately, and then among the females of Britain's royal families. As will be seen from the discussion of this material in section 4, their transition had two quite different aspects, each distinguished from the other by both the temporal separation of the shifts taking place in the longevity of members, and by the portions of the structure of age- and sex-specific mortality rates that were primarily affected during each phases. The transition to lower rates of age-specific

[22] Furthermore, it is possible separately to examine the changing relationship between the mortality of royalty and commoners at the lower end of the age distribution – as is done below, with the aid of Table 4.

[23] In addition to being plotted directly, the 25-year average estimates of e_0 drawn directly from the work of Wrigley, Davies, Oppen and Schofield (1997) have been averaged to form overlapping century-long averages that are comparable with the birth cohort estimates for royal males and royal females.

Figure 2(a): Comparative Levels of Male Cohort Life Expectancy

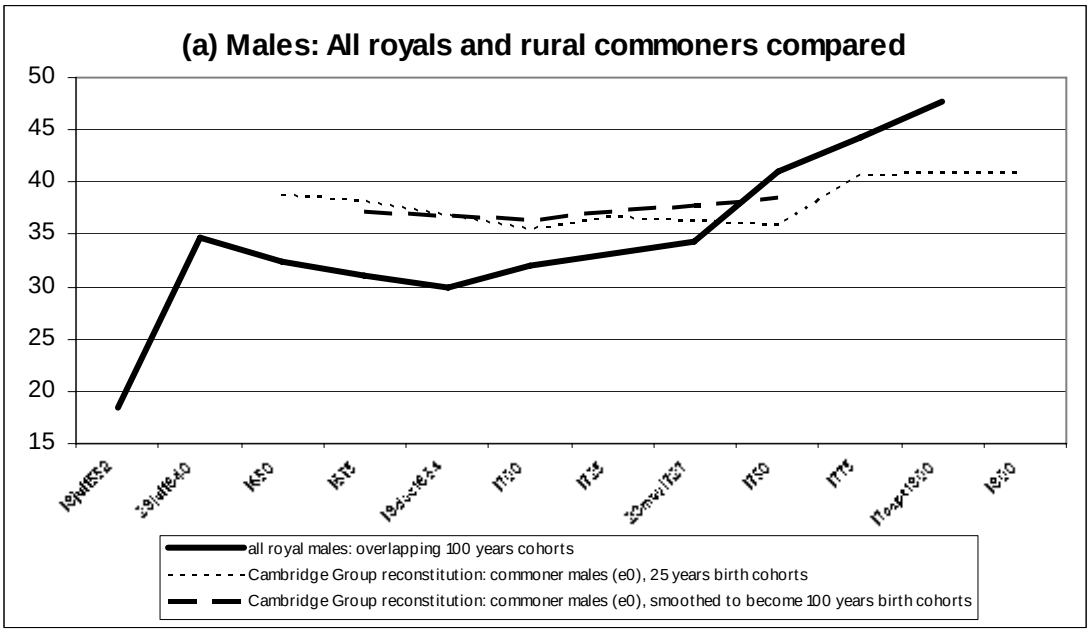
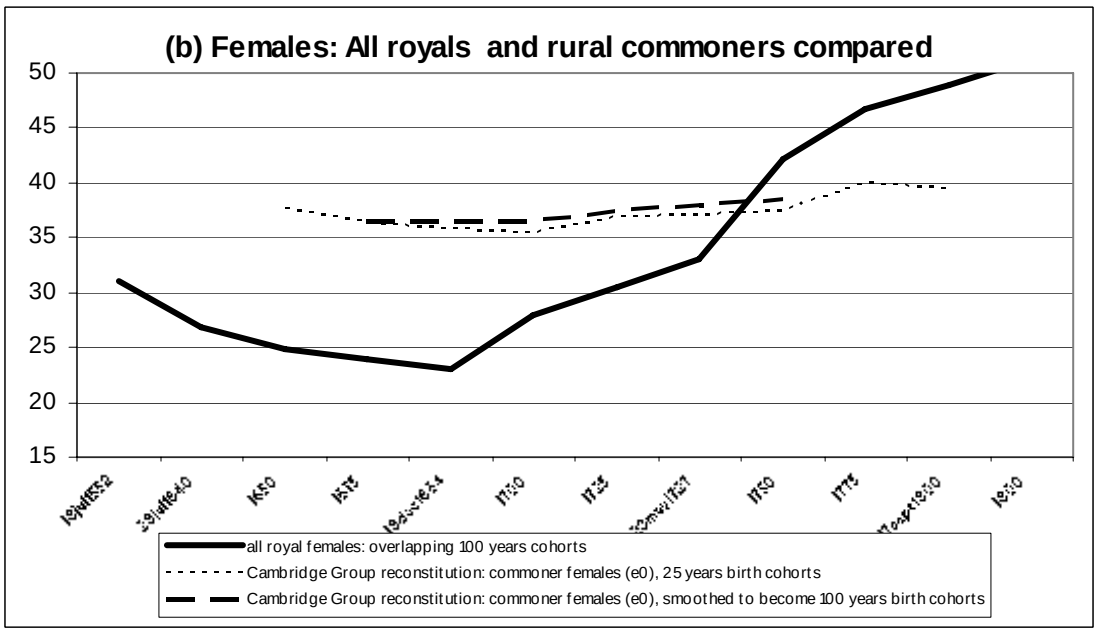


Figure 2(b): Comparative Levels of Female Cohort Life Expectancy



Sources and Notes: Cohort e_0 data for royals from DJP (2010), Statistical Appendix Tables A1.2b, A1.2d; 25-year period averages for commoners, from Wrigley, Davis, Oppen and Schofield (1997), Table 6.27. The latter are given with dates reflecting the mean age of maternity, and have been repositioned to be approximately comparable with the estimates for the royals, which are plotted at the cohort's mean death dates as follows (dates of the interpolated values of the royal series are indicated in italics). For the male royals: Cohort 0 (1550-99): 18 jul 1552; Cohort I (1550-1649): 29 jul 1640; *1675* ; Cohort II (1600-99): 19 dec 1684; *1700* ; Cohort III (1650-1749): 23 may 1727; *1750* ; *1775* ; Cohort IV (1700-99): 17 sept 1800. For the female royals: Cohort 0 (1550-99): 26 jan 1565; Cohort I (1550-1649): 14 jul 1646; *1675* ; Cohort II (1600-99); 6 dec 1679; *1700* ; *1725*; Cohort III (1650-1749): 25 may 1729; *1750* ; 1775 ; 1800; Cohort IV (1700-99): 20 jul 1802.

mortality among this elite population began with the improvement in the survival rates of men during the latter half of the seventeenth century – which is to say that it was largely confined to males who reached age 25, and found no parallel in the average experience of women in royal families.

The second phase of the gain in royal life expectancies was shared more equally among males and females and was a development of the eighteenth century, for it was driven by the pronounced drop in rates of infant and child mortality (for both sexes) that was especially marked among the royal family. More will be said about that part of the story after considering more closely the magnitudes of the preceding differential evolution of adult survival rates for the men and the women of Britain's ruling families, and the impact of those changes upon the increased longevity of males and females in the royal households between the sixteenth and seventeenth centuries.

3. Medicine and Mortality in Europe, circa 1500 to 1800

The doctors, who wrote medical histories in the 1700s, were already telling an optimistic story about the progress made by European medicine (including surgery) since the Renaissance. In the 1800s still more medical progress had been made (F. Garrison, 1913) but most of it was still perceived as coming in the form of great discoveries made by great doctors and surgeons. Relatively little attention was paid to how medical breakthroughs once made, were (or were not) translated into useful medical knowledge, or what groups were first to benefit from it.

Nevertheless, by the 1920s enough had been written about medical progress to convince several British social and economic historians that centuries of medical progress must have had implications for mortality history, specifically for the decline of mortality in England in the late eighteenth century (see, for example the detailed study of this by Buer 1926). As mortality history began to incorporate evidence from medical history, it seemed obvious that medical advances played a major role in rising life expectancy, past and present. By the 1950s leading economic demographers studying the developing countries were convinced that medical knowledge could raise life expectancy even in the absence of economic development (Demeny and McNicoll, 2006).[24]

Medical History and Medical Historians – From the Old to the New

But confidence in the power of medicine was shaken as a new generation of medical historians began to revise the past. Revisionist historians shifted the historical focus of research to the development of medicine as a profession in an historical context where physicians were not very numerous and had infrequent contact with ordinary people. Like most professionals, past or present, ordinary physicians were committed to protecting their own interests and suppressing potential rivals, not making medical progress by being innovative.

Worse still revisionist historians started to question whether or not any genuine medical progress had really been made in early modern Europe. One of the most influential of the new therapeutic nihilists was Thomas McKeown, a physician who turned to mortality history as a way of contributing to health policy debates in Britain at the end of World War II. (S. Johansson, 2004). Since he strongly favored the continuation of the government's wartime food-rationing program over the nationalization of medicine, McKeown's beliefs led him to question the historical evidence for medicine's increasing efficacy, and thus its possible role in initiating the late eighteenth century decline of mortality. Instead he assigned responsibility for declining death rates to better nutrition (largely in the form of less chronic hunger) although he gave public health some credit for declining mortality after c. 1870-1900. For McKeown the policy implications of his historical research were that to keep raising life expectancy, the British government should eliminate chronic malnutrition and,

[24] Demeny and McNicoll (p. 11) cite a group of leading economists writing for the United Nations on the problems and prospects of the less developed countries. In 1951 they stated that: "The rate of growth of population is now first and foremost a function of the extent to which medical knowledge is made available to the people."

more broadly, alleviate poverty. It should not invest scarce national resources in delivering free (tax-supported) medical care to individuals, because private medicine had never been able to reduce mortality.

From the start, Dr. McKeown's medical reasoning, as well as his use of mortality data, had its critics (S. Johansson, 1994); but his forcefully argued ideas became so influential that eventually most physicians were convinced (Golub, 1994). As the belief in medical progress became unfashionable among medical historians during the late twentieth century, economists and demographers adopted the new therapeutic nihilism. In 1992 D. Coleman and J. Salt, authors of *The British Population Patterns, Trends and Processes,* having read the latest historical research, concluded that the supposed rise of "scientific medicine" in Europe was "irrelevant" to the small declines in mortality that appeared in national level English data after c. 1780. Smallpox inoculation was a possible exception.

In effect, empirical evidence for the progress made by European medicine after c. 1500 was disregarded in favor of equally good evidence for the conservative nature of medicine as a profession. At present the kind of evidence used by old fashioned medical history "survives" but largely in the form of medical timelines that list key events in the history of innovative medicine year by year. In Figure3 data from a recent and particularly detailed medical science "events" timeline (Sebastian, 2000) is used to proxy the history of the advancement of (mainly) European medical knowledge, by tracking the explosion of innovative medical achievements in Europe from the 1500s onwards.[25]

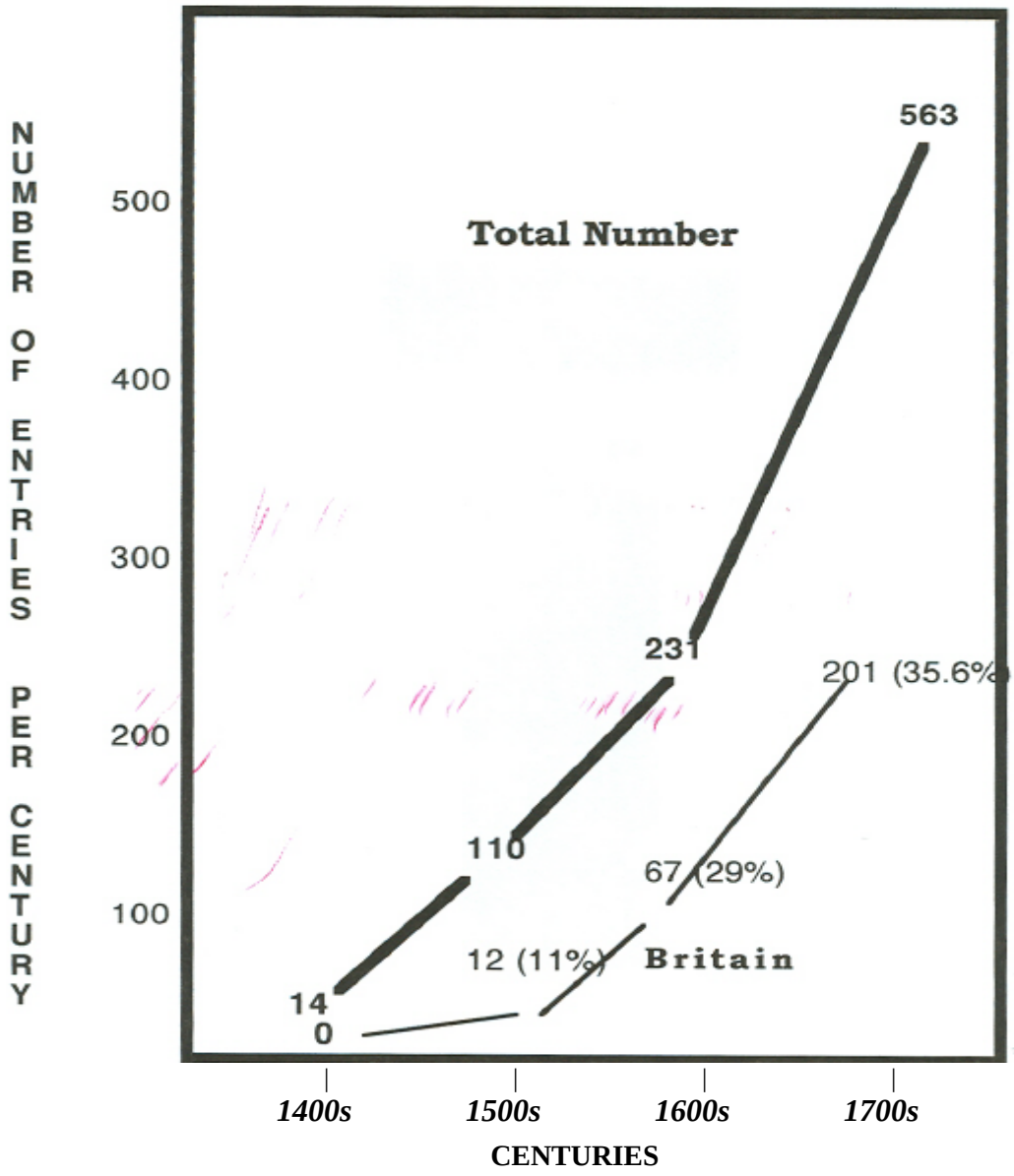
When the individual entries in Sebastian's (2000) medical timeline are summed by century, they provide a quantitative approximation of the accumulation of the kind of research that is still regarded as making a useful addition to the stock of medical knowledge, in Europe or elsewhere. Before 1500 almost all timeline entries come from outside Europe. By the 1600s they are almost all European. As can be seen in Figure 3 the pace of additions to the body of medical knowledge grew rapidly, and accelerated so rapidly that it had become super exponential by the 1700s. By global standards, European medicine had carved a novel path to the production of medical knowledge, one that favored continuing innovation over the respectful transmission of traditional wisdom. Figure 4 also indicates that England was a marginal contributor to innovative European medicine in the 1500s, but assumed a position of preeminence during the 1600s.

Although timelines provide a dramatic way to illustrate the history of innovative medicine in Europe, they cannot explain it. Nor do timelines have any obvious connection to mortality history. For example, the definitive identification of a specific disease like diabetes in the 1600s will be included in a timeline, even if nothing could be done to prevent, manage or cure that fatal disease until the early twentieth century.

[25] Medical timelines list in chronological order what the author(s) or editor(s) regard as important medical discoveries, or other medical events considered to represent some form of medical progress. All timelines indicate that the rate at which knowledge was produced in Europe accelerated after 1500. But individual timelines differ with respect to what they include and exclude. Despite their methodological commitment to objective chronological description, they all require making subjective judgments about what is most important in the story of medical progress. The timeline chosen here is the longest and most detailed I have read.

Figure 3. The Quickening Pace of Medical Advance
From the- 15th to the 18th Century

Absolute numbers of notable medical advances per century in Europe (mainly), with the share attributed to British medical practice



Notes and Sources: The compendium *Dates in Medicine–A Chronological Record of Medical Progress Over Three Millennia* (A. Sebastian, ed., 2000) contains 446 pages of entries, beginning in 8000 B.C. Although intended to be global in scope, very few entries are non-European after 1600. Listings under "Britain" include entries from England, Scotland, and Ireland, but not the Britain's American colonies.

The growth of medical knowledge in early modern Europe was driven by both religious and scientific fervor in a supportive technological context. It has long been obvious that the invention of printing made possible the subsequent creation of a rapidly growing and profitable market for medical books, but the printing press itself was intellectually neutral with respect to the content and direction of innovative medicine.

The new enthusiasm for innovation per se had quasi-religious origins. *Paracelsus* (1493-1541), one of early modern Europe's leading medical reformers, was often described by his contemporaries as medicine's Martin Luther. He vigorously denounced formal (i.e. university) medicine as corrupt and useless, and he urged physicians who wanted to make medical care genuinely efficacious to discover new drugs for specific diseases (Adler, 2004).[26] This was an exceptionally radical idea at the time, given that the very concept 'specific disease' was problematic in conventional disease theory as taught at universities (Maclean, 2002: 265).

Paracelsus was as much a mystic as a medic. Later medical reformers became more and more "scientific" in the sense of relying on observation and experimentation to make useful discoveries. If a new drug could be observed to cure a specific disease (make its symptoms disappear quickly) or a new method of medical management produced more recoveries, the new should replace the old, even if there was no theoretical basis for explaining why or even how new drugs or methods of management worked.

To the extent that formal (university-based) medicine resisted the rise of theory free empiricism, innovative physicians took risks that could foreclose the possibility of a conventional medical career. For that reason medical innovators became more dependent than ever on royal and elite patronage.

In the middle ages it had been the patronage of popes and kings that provided the kind of institutional support that made medicine into a 'science', one that could be taught to aspiring professionals at Europe's new universities – although, at the time, theology was considered to be the queen of "the sciences." Some kind of university education became a first step towards the possibility of becoming a royal physician, the "crowning glory" of a medical career. [27]

Because European rulers wanted the best medical care for themselves, they continued to patronize what they perceived to be the best physicians and surgeons (Digby and Johansson, 2003). In the 1600s, as innovative physicians and surgeons began gaining a reputation for superior efficacy over conventional physicians, royal patrons began favoring medical innovators over their more traditional counterparts. Thus at a time when many medical faculties were reluctant to appoint innovative physicians, rulers were eager to do so. In this way royal and aristocratic patronage was as important for innovative medicine in early modern Europe as it was for the continuing development of other forms of scientific and even artistic innovation in the 1500s and 1600s (David, 2008).

The body of practical knowledge produced by medical innovators after c. 1500 to 1800 included contributions to both 'public health' (defined as the prevention and containment of epidemics) and 'private health' (a concept now virtually synonymous with medicine itself). Basic research on anatomy also stimulated a new era of innovative surgery, but physicians did not perform major surgery as part of practicing medicine. Instead they routinely gave

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[26] See Paracelsus' "Seven Arguments, Answering to Several of the Detractions of His Envious Circle." This essay, which summarizes the author's ideas on medical reform, was written in German about 1537. It appears in English translation in: *Source Book of Medical History*, compiled with notes by L. Clendening, MD. The Dover edition was published in Toronto in 1960. See pages 95-105.

[27] This was the situation in England, and Scotland, but not universally in Europe, where the relationship between royal surgeons and universities varied from country to country.

health advice to their patients about how to prevent disease, and they treated those diseases that could not be prevented, mostly with drugs prepared by trusted apothecaries. But as advisors and healers physicians treated adults until the late 1600s, when the formal "medicalization" of elite infancy and childhood began.

Although the diseases treated by physicians and apothecaries struck men and women alike, the specialized treatment of diseases specific to adult women were relatively neglected until after 1800. However, in the 1600s innovative surgeons had already begun to improve the management of difficult births (including stillbirths) with an eye to saving the lives of childbearing women, elite or not. It was in this overall context that European medicine made progress, albeit of a halting and uneven kind that benefitted elites first and foremost. Europe's elite adults benefited from the attentions of the practioners of innovative medicine sooner than their children, and among the elite adults, the medical condition of the men appear to have been a greater, and temporally earlier focus of treatment compared with that received by women.

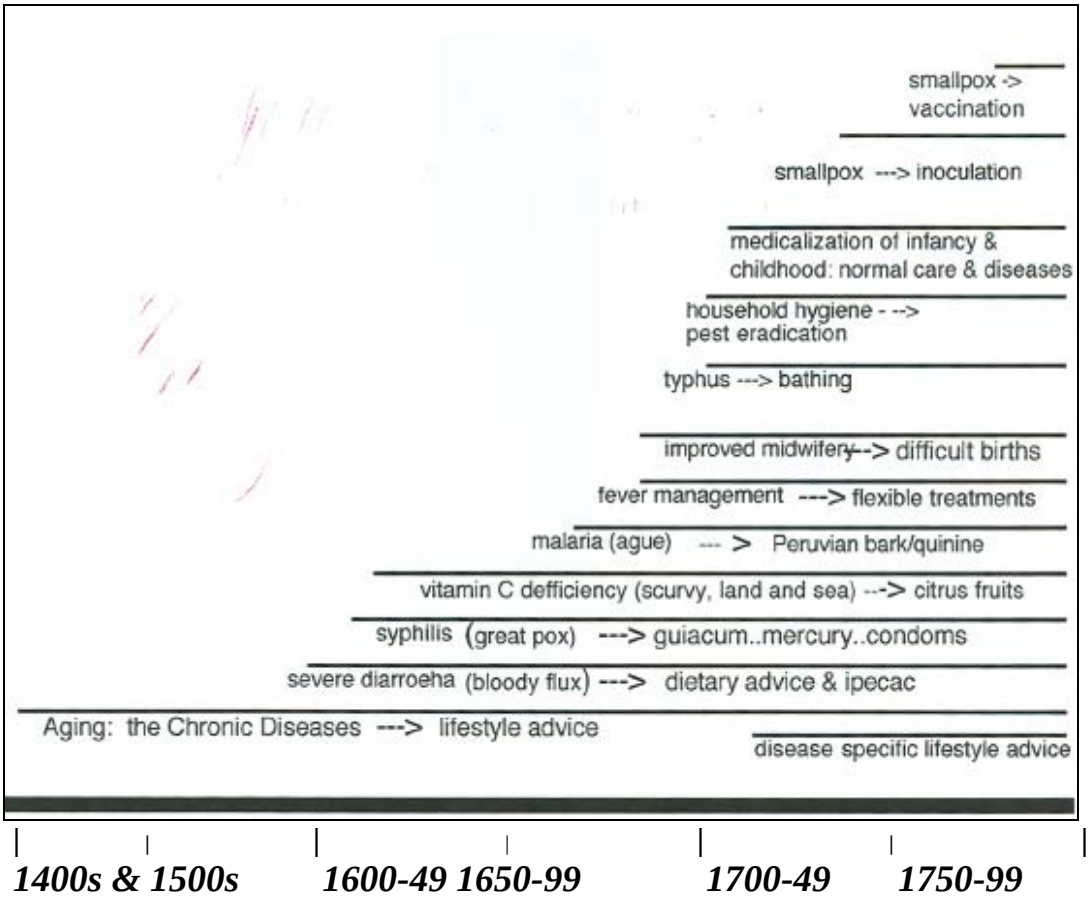
Figure 4 locates in time those medical innovations that are most likely to have been relevant to explaining some of the age and gender-related aspects of elite life expectancy history in early modern Europe. Behind each entry in Figure 4 is a long, complex story of how some kind of useful knowledge was produced, medically legitimized, and delivered (initially to those who could afford it) long before the germ theory of disease revolutionized private medicine and made public health into a separate branch of medicine. The stories are told in a very sketchy and necessarily inadequate form; but they give some idea of how it was possible to make medical progress of a kind that could reduce elite mortality, even in a context where so little was known about the fundamental nature of disease processes.

It is important to understand that innovative physicians and surgeons did not work in isolation. Physicians, surgeons and apothecaries (pharmacists) were at the core of what amounted to an evolving information-processing network that included interested laymen and women as well as medical irregulars, i.e. those men and women healers who were informally trained, and generally considered a threat to the medical establishment (Pelling, 1997). Europe's medical network also included popularizers who wrote in the vernacular languages, in order to make medical research originally written in Latin available to those who could only read a vernacular language. The process of discovering a useful new drug often began with an explorer, merchant or missionary, who imported it to Europe and drew the medical profession's attention to its putative properties.

In general, the accelerating production of medical knowledge in Western Europe was one aspect of the first wave of globalization based on exploration and trade. Initially Europe began as an importer of miracle drugs used elsewhere long before it became an exporter of useful medical knowledge to the non-European world. Nevertheless, within Europe new ideas and new drugs had to be medically "legitimized" before they became part of elite medicine. Not surprisingly innovative medicine included experimenting on ordinary people (often the hospitalized poor) before some specific form of medical care was deemed safe enough to be delivered to patients wealthy enough to pay for it.

Figure 4. The Developing Stock of Useful Medical Knowledge: Timelines

Approximate dates of the emergence of knowledge available to European physicians and surgeons who served elites, relating to the prevention, management and treatment of specific diseases and medical conditions



Source: Constructed on the basis of the medical history sources discussed in Johansson (1999).

Innovative medicine and the Chronic Diseases of Adulthood and Old Age

One of the most surprising features of the elite rise in expectancy in the 1600s was that middle-aged and older royals began to live longer, well before infant and child mortality began to decline. Model Life Tables tell us that when life expectancy at birth is about 30 years of age, as it was in Europe in the 1500s and 1600s, half of the ever born (not including stillbirths) will be dead by 20 years of age; but circa 30 per cent of those born will survive to reach 50 years of age, and about 10 per cent will live as long as 70 years (Coale and Demeny, 1983). Early modern Europeans could not consult model life tables, but they knew from casual observation that relatively few people, rich or poor, survived to age 70, just as they knew from experience that those adults who lived as long as 50 years were increasingly likely to suffer and die from the chronic diseases then as now associated with ageing.

As early as the 1200s Europe's leading physicians began to advise royal and elite patients that as mature adults they could postpone the onset of the chronic diseases, and thus live longer, by making what we call healthy lifestyle choices (Mikkeli, 1999). Medicalized

lifestyle advice was originally developed by Greek and Roman physicians in the ancient world; but it was lost as Pagan Europe became Christian Europe. After c. 1200, lifestyle medicine was revived by innovative university physicians, who gained access to texts written by physicians practicing in the Islamic world. They in turn had preserved and augmented Grek and Roman lifestyle advice since the 700s (Bovey, 2005). At first, Europe's rulers received lifestyle advice in the form of a single book written by a single physician for a single king. But in the 1500s the printing press made it possible to popularize regimen advice, and it became an integral part of elite medicine.

Renaissance lifestyle advice counseled adults to eat simple food in modest amounts, drink alcohol only in moderation, exercise regularly, get enough sleep, and avoid emotional excesses (Mikkeli, 1999). Such advice is familiar to health conscious people today, but it was novel in 1539 when Sir Thomas Elyot, published the second edition of his *The Castell of Helthe*. Elyot wrote in English so as to make medical advice written in Latin available to people who could not read it, which at the time would have included most elite women as well as many otherwise literate but not university-educated men.

A century later, books containing lifestyle advice were so popular in England that they constituted a medical genre of their own (Smith, 1985). As trade expanded with the rest of the world, the domain of lifestyle advice also expanded to include advice about new and unfamiliar foods and beverages imported into Europe (including tea and coffee). Tea was highly regarded, coffee less so, but each provided a healthier alternative to drinking alcohol in various forms, or, worse still, water. Smoking tobacco was controversial.

A more extreme form of life-extending medical lifestyle advice was also popularized. In 1558 an Italian nobleman named Luigi Cornaro adapted some ideas being explored by Italian professors of medicine who stressed the life-extending benefits of severe caloric restriction. Thus Cornaro advised his readers to eat as little food as compatible with the avoidance of starvation. By doing this adults could anticipate living to 100 years or more in good health (Gruman, 1961). Cornaro himself claimed to have lived that long, but more likely he "only" survived into his nineties.

Modern biological studies have confirmed that severe caloric restriction can lengthen the lives of laboratory mice by as much as thirty per cent (Finch, 2006). What "underfeeding" could do to lengthen adult human lives in early modern Europe, where life threatening infectious diseases were much more common than they are today, remains unclear. Nevertheless, modern demographic research on lifestyle choices and relative longevity has found that mature men living in developed countries can expect to live for *at least* six to seven years longer on average than men who do not make healthy choices; whereas women who do can add only an additional two or three years to their lives. But, today as well as in the past, lifestyle excesses among women generally are less common than those found among men, at least not until very recently (Johansson, 1991). Life style advice offered to the adult elites of the early modern period therefore most probably would have done more to increase the men's longevity than that of the women.

Because we don't know what percentage of elite adults followed regimen advice in the 1500s and 1600s, either in its moderate or extreme forms, we cannot formally estimate its potential effects on elite life expectancy. But it is probably more than merely coincidental

that as lifestyle advice became a standard component of elite medical care, receptive adults in Europe's ruling families who were older than 50 and even 70 years of age began to live a few years longer on average, as has been seen in Table 1. If nothing else, the growing confidence in lifestyle advice had the effect of weakening traditional fatalism of the type that took each individual's lifespan to be predetermined by God and beyond the power of man to alter.

Because royal physicians saw their royal patients frequently, they were able to deliver health advice often enough to increase the probability that it would actually be adopted. Even so not all royal patients were converted to healthier lifestyles. Excessive alcohol consumption continued to be a problem among some English kings and certainly male aristocrats even in the 1700s after a century or more of medical advice for moderation.

In Britain as more royal and aristocratic patients began to survive to old age, physicians began to pay more attention to the *specific* chronic diseases associated with aging. In the l800s advances were made with respect to the identification and treatment of heart disease among the living (as opposed to identifying heart failure after death through an autopsy). Angina was one of the first forms of chronic heart disease to be given a specific name, along with medical advice specific to it. (L. Michaels, 2001).

Treatment of Acute Diseases and Adult Life Expectancy

Despite the popularity of regimen/lifestyle advice, many economically and socially privileged adults living in the 1600s and 1700s continued to die between the ages of 20 and 50 years. Many fell victim to those acute diseases that seemed to strike suddenly and kill quickly; often those adults who survived an acute disease were left permanently debilitated.

As the concept 'specific disease' became more salient among innovative physicians, they began to look for specific ways to prevent, manage or cure those diseases whose symptoms had always made them relatively easy to distinguish from other diseases. One acute, life threatening and easily identifiable disease prevalent in the 1500s was the *bloody flux* or severe diarrhea. When the bloody flux could not be stopped using traditional medicines and methods of management, it caused death from severe dehydration.

European physicians were keenly aware that an ounce of prevention was worth a pound of cure. In this case they noticed that outbreaks were particularly common in the spring, just when Europeans resumed eating fresh vegetables and fruits. It seemed reasonable to advise patients to avoid foods that were correlated with outbreaks of diarrhea. But only the rich could afford to subsist on a "safe" meat and bread diet (in which the bread was white so that it could be seen to be free of mold). But reducing the risk of severe diarrhea by eating only meat and bread could cause chronic constipation; in addition any individual rich enough to eat only meat and bread was at risk of developing land scurvy.

Eventually, a new drug called ipecacuanha (or ipecac) was imported from Brazil in the 1500s. It was supposed to be a more effective means of medically managing attacks of severe diarrhea, thus reducing the risk of death. Today ipecacuanha (or ipecac) is still used to

manage diarrhea; but for centuries is was hard to obtain and therefore expensive. Thus, high costs long limited its use to elite patients who could afford it.[28]

(i) Syphilis:

"The Great Pox" was widely perceived as a new acute disease introduced to Europe by Columbus' sailors in the late 1400s. Initially it spread rapidly and killed quickly, usually within one or two years after its distinctive sores became visible. But Columbus, having imported the disease, also imported the medicine used by Caribbean natives to "cure" it. This new drug was a tree bark called "guaiacum," which became known in Europe as the Holy Wood. Within decades of its importation this new medicine became the basis for a small industry that turned raw tree bark into a medicinal powder. Once again, to the extent that this imported drug remained both scarce and expensive, it use was confined (sometimes by law) to the nobility. The mercury cures favored by Paracelsan reformers were cheaper, but their toxic side effects were more severe (Fabricius, 1994).

As the use of the Holy Wood and mercury became more common in the 1600s, physicians believed that they had found useful cures for syphilis. More likely they found a means to slow the progress of the disease and lengthen the time between diagnosis and death. In this respect the history of syphilis in Europe had something in common with the history of twentieth century HIV/AIDS. When that new and deadly venereal disease began to kill Europeans and Americans in the early 1980s, it usually caused death within a year or two of being diagnosed. But very soon (at least by historical standards) a cocktail of retroviral drugs was developed to check the multiplication of the virus that causes the fully developed disease. These anti-retroviral drugs do not cure, but they restore partial health and lengthen life despite their toxic side effects.

Not surprisingly early modern Europe's physicians agreed that abstinence outside marriage and fidelity within it was the best way to avoid any disease that seemed to be sexually transmitted. But then as now such lifestyle advice was unpopular. Eventually, condoms were invented in the mid-1600s by an English doctor named Condon or Condom (possibly a mythical figure). The new penile sheaths were made from animal intestines, and by the l8th century they were already being widely sold in London, but at a very high price. Once condoms became a way of avoiding venereal disease, and medicines were available for those who could afford treatment, un-treated cases were observed more frequently among the poor rather than the rich.

(ii) Fever: from a disease to a symptom

The most frequently treated acute disease in early modern Europe was probably 'fever' meaning any persisting or recurring high temperature. As long as fever was still regarded as a disease, it was usually medically managed by 'sweat and hot keeping", which meant confining the fever patient to a dark, airless, overheated room. In effect this method of medical management involved taking a chance that by raising a patient's temperature still further, the fever would burn itself out before killing its victim.

[28] Ipecac was mentioned in English medical texts as early as 1625. See Schmidt (1959: 136).

One of England's most innovative physicians, Dr. Thomas Sydenham (1642-1689) challenged this very rigid method of fever management by converting fever from a single disease to a symptom of many different diseases. Sydenham began by experimenting on fever patients in one of London's few remaining hospitals for the poor. There he observed that more of his patients recovered if they were kept cool in well-aired rooms rather than kept very hot in closed rooms. As he began to associate specific kinds of fevers with specific acute diseases, he continued to experiment with much more flexible forms of medical management. Since time intensive medical supervision for fever patients became more expensive (each doctor's visit required a payment) rich fever patients were more likely to be treated more flexibly and safely than poor patients, at least until charitable fever hospitals were set up in London during the last half of the eighteenth century, and subsequently in other English cities.

Dr. Sydenham was innovative in many other respects. He experimented with using iron filings to treat the green sickness, now thought to be iron deficiency anemia. To relieve pain more effectively he developed a more concentrated extract of opium and mixed it with alcohol. Initially his new version of the old laudanum was intended to counter the extreme pain associated with gout, from which Sydenham himself suffered. Since his new version of opium was so much stronger than the old, some patients became addicted.

Sydenham became a medical innovator without receiving much institutional support. Royal patronage was out of the question because throughout all his adult life he remained a convinced Puritan, who adamantly opposed to the restoration of the monarchy. Sydenham's commitment to innovation had religious roots. Like Paracelsus he believed that for every specific acute disease God had created as a punishment for sin, He, in His mercy, also had created a specific remedy for it. Doctors had the sacred duty to discover those divine cures through observation and experiment. While he was alive, Sydenham's innovations – having found no patrons – remained controversial; only after his death was Sydenham hailed as the English Hippocrates, and even later as a "father of modern clinical medicine."

The treatment of *scurvy* in Sydenham's time already fit the model of one specific cure for every specific acute disease. In the 1500s medical texts described the disease called scurvy *(*now *vitamin C deficiency)* as having become more prevalent: "sea scurvy" undoubtedly became more common as sea voyages themselves became longer. Land scurvy (the same disease) would have become more common as the fear of bloody dysentery made eating fruits and vegetables seem dangerous.

By 1600 sea captains who sailed to Portugal and Spain learned that scurvy could be cured within a few days by simply consuming oranges. (Citrus fruits originating in China were already being grown in Spain and Portugal in the 1400s.) This knowledge was adopted and legitimized by innovative physicians in England in the early 1600s.[29] Once oranges were perceived as having the power to both cure and prevent scurvy, without the associated danger of dysentery, it was medical advice, not a mere taste for a novel fruit, that led Northern Europe's royal and/or richest families to build their own *orangeries* (glass enclosed, heated green houses). These greenhouses insured that wealthy families had a steady supply of oranges even out of season. (Today we know that the removal of the orange peel protected

[29] In England citrus fruits were advocated as cure for scurvy in books published as early as 1617.

the consumer from exposure to the surface pathogens that could otherwise contaminate the surfaces of ordinary fruits and vegetables.)

It took decades before the British navy addressed scurvy as a growing health problem among its ordinary sailors, partly because oranges were so expensive. Once lemons and limes became cheaper substitutes, the navy became more receptive to providing them, especially as continuing medical research demonstrated their efficacy (Bown, 2003). But for lesser folk oranges long remained an expensive luxury commodity. In London, as late as 1800, most people could still not afford to buy citrus fruits on a regular basis, or even fresh vegetables in the winter. One consequence was that long after scurvy was no longer prevalent among the rich, leg ulcers (a common symptom of scurvy) remained a common complaint among the poor who sought treatment at London's hospitals (Loudon, 1981).

(iii) Malaria – the Ague:

Malaria was another deadly or debilitating acute disease common in certain parts of Europe, for which a simple efficacious new drug was found in the 1600s. Ague was relatively easy to distinguish from other fevers, because the patient's temperature rose and fell every three to four days (depending on the specific strain of malaria involved). The most deadly strain killed quickly; but the weaker form left its victims alive but vulnerable to other diseases.

Both types of malaria had long been present in Europe wherever there were marshy areas (Dobson, 1997). Such areas may have become more prevalent in England after 1600, as its forests were cut down to build ships and provide fuel. As more roads were built to transport lumber, they were soon full of potholes in which mosquitoes could breed.

Western European medicine addressed this particular disease by importing another non-Western drug to cure it– this time cinchona bark from Peru. When properly dried, prepared and administered correctly this particular tree bark cured the disease in the sense of making its symptoms disappear very rapidly. But since one attack of the disease did not confer immunity, regular doses of cinchona bark were necessary to prevent a reoccurrence. Given the continuing expense involved, only rich families could routinely rely on this imported tree bark to both preventive and cure malaria. The poor had to depend on individually or civically sponsored rural and urban drainage, a form of public health measure that became more and more common in the eighteenth century.

Malaria in its milder forms had afflicted almost every seventeenth century ruler of England, including Oliver Cromwell, probably because they were still militarily active men who camped out in marshy fields as part of leading their armies. When Cromwell was offered the chance to take cinchona bark for his ague, he refused, simply because it was still called "Jesuit bark" (Spanish Jesuits had originally imported it from Peru to Spain). The English apothecary Robert Talbor removed this cultural barrier by making cinchona bark the basis for his secret remedy, which he called "the English remedy." For curing King Charles II, Talbor was made a knight. He was also hired and paid well by Louis XIV and (ironically) Luisa Maria, Queen of Spain. Subsequently, Dr. Sydenham proved that Talbor's secret ingredient was cinchona bark.

We now know that the tree bark used to cure malaria contained quinine, a drug which remained effective until the mosquitoes that transmitted it became immune to it. Because

cinchona bark was so demonstrably effective, the demand for it rose quickly. Since the supply remained limited, its price stayed high. In this context, dishonest apothecaries routinely substituted the bark of cherry trees for cinchona bark, which eventually cast doubt on the supposed efficacy of "the bark." Only very wealthy patients, who could pay very high prices to the best apothecaries, could be sure of getting the real thing, and thus benefit from the new medicine.[30]

In any case innovative medicine in early modern Europe managed to make disease-specific progress, and deliver that progress to elite patients so effectively that by circa 1700 a set of acute diseases once described as prevalent and deadly among adults, including elites, could be prevented, or more effectively managed, or even cured. From a demographic perspective this could hardly have done anything but exert a downward force on death rates, at least among the set of exposed adults who could afford to obtain the best medicine that money could buy. Those who could not (i.e. the vast majority of any national populations) would have remained vulnerable and more subject to the risk of premature death until their incomes rose or costs fell.

Modern demographers have access to a large amount of high quality cause of death data, such as those compiled in *Causes of Death Life Tables for National Populations* by Preston, Keyfitz and Schoen (1972). Such data have been used to estimate how many years were added to a country's life expectancy at birth as single causes of death (or closely related causes of death) came under control in late nineteenth and early twentieth century.

Although there is cause of death data available for kings before 1800, it is generally inadequate for modern demographic purposes. Doctor-historians who have considered the available source material disagree on the specific causes of king's deaths, partly because kings often suffered simultaneously from more than one disease, acute and chronic (Brewer, 2000). For queens there is even less reliable cause of death data available until the 1800s; and infant cause of death data is sketchy at best.

What can be said is that by the 1700s the titular kings of Britain began to live longer lives and died from chronic diseases, uncomplicated by one or more or of the acute diseases so prevalent a century before.

In mortality history when the chronic diseases replace the infectious or vector borne as leading causes of death, this process of substitution is called the *epidemiologic transition* (Omran, 1971). For ordinary Europeans this cause of death transition took place over the first half of the twentieth century. At the global level it has now taken place in most but not all developing countries. For Britain's kings and even queens, the epidemiologic, cause of death transition was complete before 1850.

[30] In England willow bark, which contains a natural form of aspirin, was initially promoted in as a cheaper alternative to cinchona bark (Jeffreys, 2005). Although it did not cure the disease, it was increasingly appreciated for its ability to treat painful headaches.

Public Health and Hygiene

It is tempting to read the recent present back into the past and ask to what extent the escape of the royal (and the elite more generally) from premature death associated with infectious and vector borne diseases was linked to better "public health." It is not a foolish question. Royal physicians began giving their patients "public health" advice in the middle ages, by encouraging them to flee local outbreaks of the plague – usually but not always the bubonic plague. Very rich people could afford to follow that advice – they had some place else to go – but most ordinary people did not. They stayed in a stricken city and died in such large numbers that the urban economy collapsed.

English royals fled the plague so successfully that none died from it after 1500. But that escape did not raise the otherwise low level of royal life expectancy at birth, either in the 1500 or 1600s. That is not surprising since royal families remained vulnerable to a number of other epidemic diseases like smallpox. Books on life at court written by prominent European doctors in the 1600s, continued to describe palaces as unhealthy places, and "courtiers" themselves as particularly unhealthy people (Kummel, 1990). [31]

Recently when a physician/historian retrospectively "examined" England's ruling family in the 1600s, based on descriptions of the diseases from which they suffered while alive, he called them *The Sickly Stuarts,* partly because they were afflicted with so many diseases at once (Holmes, 2003). Given that most Stuarts had multiple diseases, it is not surprising that their family life expectancy at birth remained in the mid-twenties, despite the fact that they routinely (and successfully) fled outbreaks of the plague.

By the late 1600s London physicians agreed that, plague or not, London itself was an unhealthy place. King William III, who suffered from severe asthma, was advised to spend as little time in London's polluted air as possible. Logically enough physicians began advising other wealthy patients to escape central London and its frequent epidemics, or at the very least, move out of the most unhealthy parishes–which, in London, could be identified by reading the weekly bills of mortality. As new housing was built for the richest families in newly developed areas of London, pipes brought water to their homes, and wider streets kept the local environment cleaner.

The fact that private patients, royal or not, were being given what amounted to public health advice by their physicians was a natural extension of the role played by royal physicians in the evolution of civic public health measures. Modern public health began in Italy in the early 1500s when governments began consulting physicians on how to prevent epidemics or, at the very least, contain their spread. Some of these innovative Italian measures were quickly imported to England by royal physicians who themselves had studied in Italy. During the reign of Henry VIII (1509 -1547), when the palace population was stuck by a deadly epidemic of the sweating sickness, sick courtiers were quickly isolated from those who were not (visibly) afflicted, and public access to the palace was restricted.

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[31] When Dr. Ann Carmichael (1989:34) examined extensive descriptive material on the individual health status of the Medici (who ruled the city of Florence in the 1400s and 1500s) she concluded that "suffering mediated the lives of the Medici as much as it did the existence of their poorer, less advantaged contemporaries."

In the 1600s those physicians who treated a king in the morning, could spend the afternoon conferring with officials on how best to manage London's latest epidemic. Since preventing epidemics had long meant cleaning the streets of accumulated filth and rubbish, medical trust in civic hygiene could only have favored the idea that greater domestic and personal cleanliness could also help prevent epidemic disease.

By the late 1600s English doctors were encouraging their private patients to bathe frequently, although they could not agree on whether hot or cold baths were best. Physicians also encouraged the belief that cleaner houses were healthier than dirtier ones. By circa 1700 domestic hygiene advice included keeping flies off food and bugs out of bed. (Bedbugs themselves, however repulsive, do not transmit any diseases to humans, but observers could not know this). As a result, insect and pest eradication became a new kind of business enterprise in London serving elite households and, of course, the royal family.

As England's London-based elites began to favor cleaner bodies and cleaner houses, their individual immune systems may have been less constantly stressed by frequent infections. This would mean that they were also less likely to suffer from the damaging side-effects of chronic inflammation, which is a natural consequence of the body's immune response (Finch, 2006). But, neither personal nor domestic hygiene would have prevented, treated or cured acute, killer diseases such as scurvy, malaria or syphilis, let alone smallpox.

Smallpox: from private health to public health

By the late 1600s as epidemics of bubonic plague broke out less frequently, the most feared epidemic disease in Europe became smallpox. Contemporaries estimated that it caused at least one out of ten deaths in eighteenth century Europe. Among England's royal family smallpox alone brought the Protestant Stuart line to an end when Queen Anne died in 1714. Earlier the disease had killed her older sister, Queen Mary II, and it killed at least two of Anne's three live-born children. In effect, it was the threat posed by smallpox to royal lives that led to the greatest triumph of English medicine – the development of *inoculation for smallpox* in the 1720s – inoculation being the medical precursor of vaccination.[32]

As early as the 1710s England's Royal Society (originally founded by Charles II to promote the production of useful knowledge in all fields including medicine) used its journal, the *Philosophical Transactions*, to solicit information about smallpox from doctors practicing anywhere in the world. The Society received descriptions of different methods being used abroad from as far away as Turkey and even China, but took no action.

Several years later Lady Mary Montague, the wife of the English ambassador to the Ottoman Empire, had her son "inoculated" for smallpox by an old Greek woman in Istanbul. This particular example of folk medicine was popularly believed to prevent a full blown attack of the disease by causing a very mild one that rarely scarred or killed. Nevertheless

[32] Inoculation transfers smallpox pus from an infected to an uninfected person in order to cause a very mild case of a very dangerous disease. Vaccination, developed at the end of the 1700s, is based on the use of matter from someone who has cowpox not smallpox. Cowpox and smallpox are related diseases.

Lady Montague was worried and she asked the English surgeon in residence at the embassy (Mr. Maitland) to observe and even assist with her son's inoculation. Maitland subsequently returned to London, and in his new position as a royal surgeon he proposed inoculation as a genuinely effective means for converting smallpox from a killer disease to a mild one.

In 1721 the King, at the urging of the royal physicians and surgeons, approved a medical experiment on prisoners already condemned to death. About six volunteers, who showed no signs of having had the disease previously, were inoculated for smallpox. All survived without any ill effects. One prisoner (a woman) was assigned to nurse a particularly virulent case of smallpox, again with no ill effects.

This great medical experiment received nationwide publicity; and royal support gave interested physicians or surgeons the freedom to privately experiment with inoculation. By 1722, Dr. James Jurin, a physician and member of the Royal Society, called for and had received data from innovatively inclined physicians who had performed over 200 inoculations. According to Jurin's data only one in 91 persons died from smallpox after being formally inoculated, whereas under natural circumstances one in 14 persons who caught the disease naturally could be expected to die (Rusnock, 2002).

Throughout the decades 1730-1760 inoculation remained a form of private medicine available only to the rich. English physicians, who monopolized it kept it expensive by expanding the process to include at least a month of before and after medical supervision. To supervise a single patient, an individual physician could charge up to 25 guineas, or the rough equivalent of about two years' salary for an ordinary agricultural laborer. At those rates inoculation remained far too expensive, even for London's middle class families who lived on fifty to several hundred pounds a year.

The cost of inoculation fell rapidly in the 1750s when a family of innovative English surgeons (the Suttons) simplified the procedure and reduced its cost to pennies a person. Based on their own data, the Suttons could assure potential customers that their methods were safer than those used by physicians (Razzell, 2003).

As costs fell dramatically what amounted to a rural public health campaign swept England. In parish after parish poor law officers paid to have all their unexposed parishioners, adults and children, inoculated. Inoculating an entire parish was seen as an investment designed to save taxpayer money, since during an epidemic of smallpox the cost of burying the dead poor, as well as medically assisting the sick and disabled poor rose dramatically, and so did the taxes needed to fund those benefits. Mass inoculation remained less popular in towns possibly because so many people moved in and out frequently that they seemed less effective (Razzell, 2003).

As early as the 1720s all the royal children were routinely inoculated for smallpox, and *none* of them subsequently died from it as children or adults. But in France, King Louis XV and several of his adult relatives were killed by smallpox in the epidemic of 1774. The French medical establishment, convinced that inoculation was another example of English medicine's reckless (i.e. theory free) empiricism, had forbidden the process. It took a political revolution to end the excessive conservatism of organized French medicine.

Innovative Medicine – Treating, Women and Children

If innovative medicine began to save some royal and elite adults from premature death in the l600s, as it surely must have done, it seems to have been more effective for adult men than adult women, most particularly for husbands rather than wives. Throughout the 1600s innovative medicine paid relatively little attention to the special medical problems of women. It was innovative surgeons, not physicians, who turned their attention to the management of childbirth. In particular, the innovative French surgeon, Ambroise Paré (sometimes called the father of modern surgery) developed a range of new techniques for managing difficult births. He subsequently taught his methods to a few French midwives, who were quickly hired by the French royal family. In contrast, English physicians would not allow male surgeons to train midwives in the new techniques, even though London's midwives officially petitioned to be allowed to learn them (Everden, 2000).

Gradually, English midwives who wanted the best care for their patients were forced to ask specialist male midwives for help when they found themselves dealing with a difficult birth, or an anticipated stillbirth. But risk-averse pregnant women in wealthy families began to routinely request the presence of male midwives at all their deliveries, just in case a routine birth proved to be difficult (Wilson, 1997). As a consequence, the status of women midwives began to decline in England, along with their chances of receiving formal training. By contrast, in France and Sweden male doctors actively encouraged specialized medical training for traditional midwives. In any case, in those areas of Europe where the new midwifery replaced or supplemented traditional midwifery, normal maternal mortality rates were cut by a third to a half as early as 1750 (Schofield 1986; Riley 2001: 13). Currently, modern medical research suggests that the set of medical innovations made in the 1600s by innovative surgeons interested in midwifery still have something to teach to the developing countries today (De Brouwer, Tonglet, Van Lerberghe and Van Lerberghe,1998).

In contrast, the diseases perceived to be specific to adult women who were past childbearing did not attract much specialized medical attention from physicians until the early nineteenth century (Mosucci, 1990). Long standing cultural prejudices made it difficult for male physicians to treat women's bodies (including queens' bodies) with the same degree of intimacy as men's bodies, including kings' bodies. The continuing need to respect female modesty retarded medical research, even of the most basic kind. For example, it was not until the early eighteenth century that the anatomical differences between male and female skeletons were investigated in detail, a century or more after the study of human anatomy, as male anatomy, was already highly advanced. The research done on female anatomy in eighteenth century medicine took place in a highly politicized context that usually involved heated debates over the equality of the sexes (Schiebinger, 1987). [33] Ironically, the more that women's anatomy could be shown to be *different and inferior* to that of men, the easier it was to justify doing medical research specifically on adult women and their gender-related diseases, as a concession to female physiological inferiority.

[33] It seems that as doctors began to investigate the natural biological differences between men and women, those differences were used to both justify women's inferiority and the need for specialized research on the diseases of women.

By the nineteenth century, when the diseases of women finally became a medical specialty, decent women, including queens, could be treated by a male physician without necessarily compromising feminine modesty. Coincidentally or not, the gradual "medicalization" of the classic women's diseases (other than childbirth *per se*) was accompanied by the disappearance of excess female mortality among royal married women.

A century earlier, as the medicalization of infancy and childhood began, there was also a decline of mortality among the children of elite families. By tradition the care of infants and sick children had long been left in the hands of women. Mothers, whether rich or poor, had to rely on their own inherited stock of knowledge, as well as advice from local (usually) women healers. But in the 1600s as innovative physicians began to do research on the diseases of children, including infants, some useful research was produced. In France once innovative physicians became interested in the diseases of infants and children, there is demographic evidence that infant and child mortality declined among French-speaking elites as early as the 1690s (Perrenoud, 1997).

In England the first royal physician to show an interest in the diseases of infants and children seems to have been Dr. William Harris, a physician serving Charles II and William III in the last third of the 1600s. Both kings were officially childless, but Charles had more than a dozen illegitimate children for whom he showed genuine regard; and, in the meanwhile, a future Queen of England (Anne) was producing and loosing infants (i.e. potential heirs) on an annual basis.

As early as 1689 Dr. Harris wrote a book about how to improve the management of the acute diseases of infancy, and in l698 he published another book on treating the major diseases of childhood (Sebastian, 2000). The growing interest among royal physicians in the diseases of infants and children was followed by a spectacular fall in royal infant and child mortality, as will be seen from the discussion of Table 4 in the following section. The specific breakthroughs involved in this fall, other than inoculation for smallpox, remain obscure.[34] But part of "pediatric medicine" dealt with improving the routine management of normal infancy, not just treating disease.

In London the medicalization of infancy and childhood did not begin among the middle classes until Queen Charlotte, wife of George III, had herself painted reading a book on the latest methods of infant and childcare. The queen gave birth to 15 children; none of them were stillborn and none died in their first year of life – a royal first. By the 1780s royal patronage encouraged what amounted to a nationwide campaign to reduce infant mortality, even among ordinary people. Coincidentally or not, infant mortality in England fell on a scale sufficient to show up in national level mortality data.

The excessively brief review of a selection of major medical innovations developed in Europe between c. 1500 and c. 1750 undoubtedly gives a misleadingly optimistic impression of medical "progress" in that period. But since so many contemporary medical historians

[34] A visit to the Royal Archives at Windsor Castle for the purpose of exploring the possibility of locating materials on the diseases of royal children and the frequency with which they had been attended by physicians during 1700-80, yielded the disappointing discover that individual scholars are not permitted to search the royal archives, which are the private property of the royal family. Lady Bellaigue, the librarian at Windsor, although helpful in other regards, was unable to allow me access to any relevant primary source material.

have dwelt on the most ridiculous or dangerous forms of medical care in early modern Europe, readers have been misled by excessive pessimism.

In all fairness, the history of innovative European medicine after circa 1500 was a complex mixture of useful, useless but harmless, and even some harmful innovations. What tips the balance in favor of therapeutic optimism is the fact that Europe's elites, particularly those royal families who were first to benefit from the newest medicine in its best and most concentrated forms, began to live longer than previously during the 1600s and 1700s. Where innovative medicine was at its best, i.e. England from 1680- to circa 1700, its ruling family (and aristocracy) did better than their continental counterparts. Furthermore, from the detailed demographic evidence examined in section 4 it will be seen that the particularities of the differential movements in mortality rates and survival trends, and the timing of those changes among Britain's royal families would be difficult to understand without reference to the specific historical course of progress in the medical care that was becoming available to this elite population from the mid-17thcentury onwards.

What cannot be demonstrated here, however, are the particular forms of medical care that individual kings, queens and their children received for specific diseases at specific times and places. That forms a vast topic that remains insufficiently explored, partly because early elite mortality history is widely assumed to be irrelevant to the study of Europe's later national level mortality declines. But only when knowledge-driven, elite mortality declines are perceived properly as the first phase of the modern rise of life expectancy at the national level, might research on the heath history of individual royals come to be appreciated as important enough to justify the more extensive research that could link the specifics of medical care experienced in this epoch with recorded mortality outcomes.

4. Demographic Reflections of the Knowledge-Driven Mortality Transition

The course of progress in medical knowledge from the late 16th century was reflected in the particularities of the mortality transition experienced by Britain's royal families. Their transition was quite distinct in its detailed pattern from the later decline of mortality rates among the populations of Britain and Western Europe at large. It had two quite different aspects, each distinguished from the other by the temporal separation of the shifts taking place in the longevity of members, and by the portions of the structure of age- and sex-specific mortality rates that were primarily affected during each phases.

The decline in age-specific mortality rates among this elite population began with the improvement in the survival rates of adult males during the latter half of the seventeenth century – which is to say that it was largely confined to males who reached age 25, and found no parallel in the average experience of the women of the royal families. The second phase of the gain in royal life expectancies was shared more equally among the males and females and was a development of the eighteenth century, for it was driven by the pronounced drop in rates of infant and child mortality (for both sexes) that was especially marked among the royal family.

This temporal pattern will be noted to broadly follow the shifting focus of the advances in medical care that became available to members of the royal families, and is thus consistent with the contention that the latter was instrumental in the mortality transition among this elite segment of western European society. More will be said about the leading position of Britain's royals in the eighteenth century phase of this movement, after considering more closely the magnitudes of the preceding differential evolution of adult survival rates for men and women, and the way those changes were reflected in the statistically significant gains in longevity recorded among the adult males and females in the royal households – including that of the Kings and Queens, between the sixteenth and seventeenth centuries.

The contrasting experiences of the sexes in this regard appears immediately from a comparison between Figure 5(a) and Figure 5(b). Firstly, it is seen that among those who had survived to age 25, the mean age of death (i.e., e_{25} + 25) among men in the first three of the royal birth cohorts (plotted in at the mean date of death for each cohort) lay in the range from 53 to 64 years, well above the expectation of life (e_{25} + 25) for the corresponding sub-group of women. Furthermore, while the average expectation of life at age 25 among women for these sixteenth and seventeenth century cohorts remained unaltered at the level of 24-25 years, for the men e_{25} had soared from 28 to 39 years. [35]It should not be supposed that the

[35] The resulting difference between male and female adult mortality in the birth cohorts of 1600-1699 was 14.9 years, a staggeringly large difference – considering that it did not reflect the differential exposure of royal women to maternal mortality, nor any reduction in the exposure of the men to violent deaths, as the text below points out. The small sizes of the samples notwithstanding, this difference in the mean ages at death for those who survived to age 25 (without a subsequent violent or maternal death) is so large that it is found to be statistically significant at the 95 percent confidence level – on a one-tail *t*-test, using the pooled estimate of the standard errors of the means for the adult males and the females (from DJP, 2010): Statistical Appendix Tables A.1.2). Although in the 1550-1649 birth cohort there are quite substantial male-female differences between the corresponding means for adults (9.8 years) and for the average e_0 of all the males and females (6.7 years), the standard errors are too large to allow them to rise above conventional confidence levels. See DJP (2010), Appendix A1, footnote 7 on the calculation of pooled standard errors and df for such tests.

male-female difference in this regard might have reflected a reduction in the frequency of "violent" and accidental death among royal adult males whilst there had been no accompanying reduction of the incidence of maternal mortality among royal adult females.

Figure 5(a)

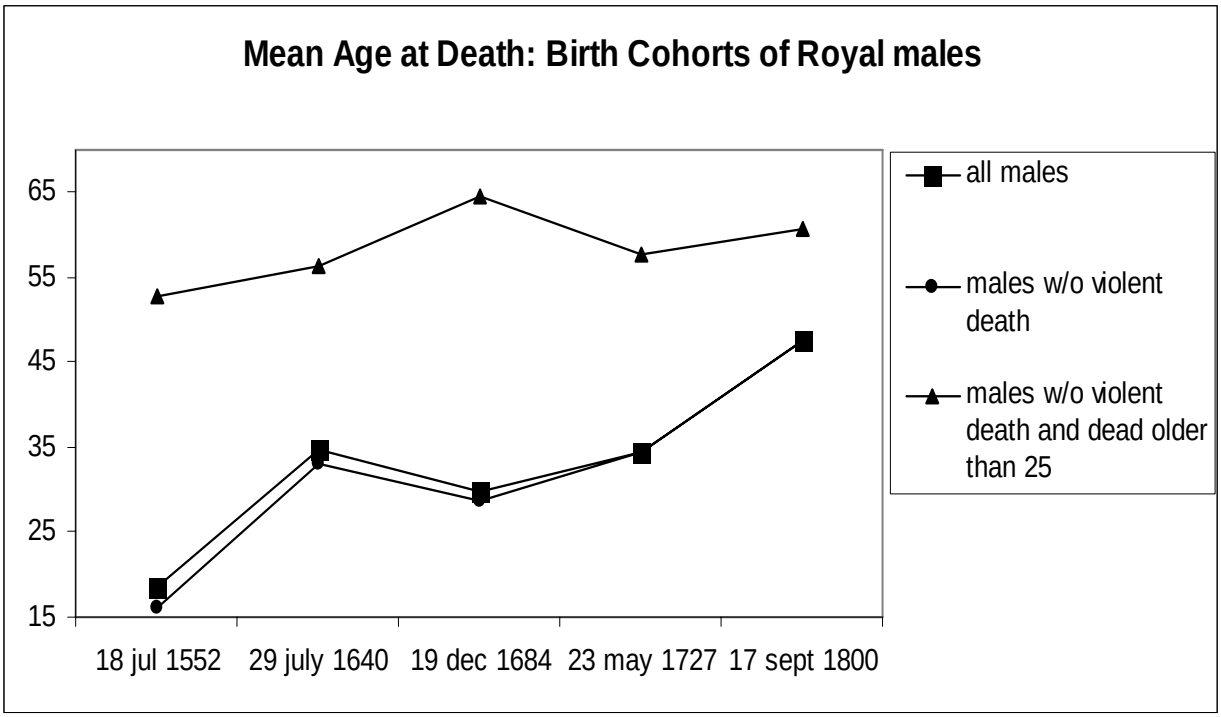
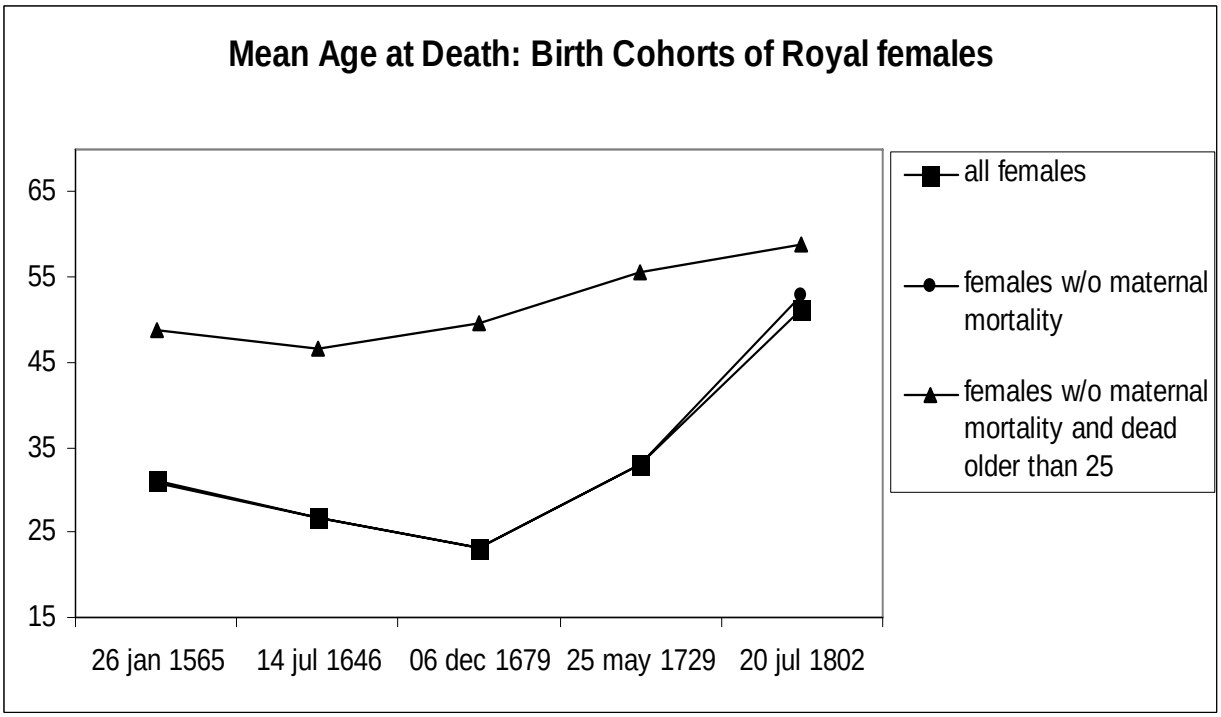


Figure 5(b)



Note: Means of age at death for each cohort are plotted at the cohort's mean death date.
Source: See DJP (2010), Appendix Table A1.2d

The estimates graphed in Figure 5(a) and 5(b) pertain to males who had died "naturally" (i.e., without violence) at ages above 25; and to females who escaped maternal mortality and survived beyond age 25.

But the remarkably high average rate of survival among these adult males who had been born during 1600-1699 was not sustained in the next century, and the extension of longevity among adult women that became discernable in the birth cohort of 1650-1749 therefore reduced the male-female difference in e_{25} to a mere 2 years. A closer look at the underlying data, however, reveals that the century-long cohort averages, while providing somewhat more precise estimates of the cohorts' mean expectations of life, mask the fact that the mortality transition among adult females in the royal families lagged that among males by a full century. The rise in e_{25} among women that becomes visible in the average for the cohort born 1650-1749 was notable particularly among those who entered it late in the second quarter of the eighteenth century, specifically George III's wife, his daughters and daughter-in-law – all of whom were born after 1740.

The effect of the royal mortality transition that began with the adult males is seen in the upward trend of cohort average expectations of life at birth among all royal males in the seventeenth century, and contributed substantially to lifting the average age at death of those in the eighteenth century birth cohort (n = 17) to 47.6 years, a level exceeding that for all of Peller's European ruling families (in the 1700s) by 11.6 years (see Table 1).[37] The lagging rise of the mean age at death among royal females is noticeable after the seventeenth century birth cohort (n=20), bringing the average during 1700-99 slightly above 51 years, which put it fully 13 years higher than the corresponding figure from Peller.

It has been seen from Figure 5(a) that the absolute and relative time-series movements in the mean expectation of life at birth remain virtually unaltered when instances of violent death are excluded from the observations for males. The same can be said of the trends exhibited by royal females in Figure 5(b), except that in this case all of the gains in life expectancy had come for those born after the mid-1600s, and so are reflected in the rise shown by the graph to have occurred following 1679 (6 December), that being the average date of death of the females belonging to the royal birth cohort of 1600-99. Here again, exclusion of instances of maternal mortality leaves the picture unchanged both in levels and trend. These gains in expectation of life among members of Britain's royal families, particularly those between the levels attained by the birth cohort of the 1700s and the two previous century-long birth cohorts, were so pronounced that (in spite of the small numbers of lives involved in those comparisons) the differences in cohort means can be accepted as statistically significant.[38] Indeed, these findings are confirmed by the results of more

[37] Royal male's mean expectation of life at birth in this epoch approximately matched that for the males in ducal families, according to the data compiled by Hollingsworth (1977: p. 32). See also Johansson (1999) for further discussion of the evidence from the ducal genealogical data that is consistent with the thesis advanced here.

[38] See DJS (2010), Statistical Appendix, Tables A1.3a and A1.4a, for results of one-tail t-tests of inter-cohort differences means (for royal males and royal females, respectively) , between Cohort IV and Cohort 0 (the 1500s), and Cohort II (the 1600s). The gain of 27.8 years for the males in the first comparison is significant at the 1 percent error level, whereas the 17.8 year gain in the second comparison is significant at the 5 percent error level. For the royal females, the gain in life expectancy (14.7 years) between the birth cohort of the 1500s and that of the 1700s was less pronounced than that among the males, and is significant only at the 5 percent level; whereas the differences between the mean age at death of females born in the 1700s and those born in

stringent statistical tests of the inter-cohort differences in the distributions of the 5-year survival rates, indicating that the significant differences between expected ages at death reflect changes in the whole structure of mean age-specific mortality rates.[39]

Thus, statistical comparisons with earlier birth cohorts and with the experience of ruling families in Western Europe as a whole support the conclusion that members of Britain's royal families born during the eighteenth century survived much longer on average than their forerunners. It appears that they also were outliving contemporary royalty on the Continent – at least in the era following the shared seventeenth century setback in the average life expectancy at birth among the males and females of ruling families on both sides of the English Channel. While, like most elites, Europe's ruling families enjoyed gains in longevity between the 1600s and 1800, the royals in Britain on average were making greater progress towards extended survival, and making it somewhat sooner.[40]

Among the residents of London, *life expectancy at birth* rose from a low of c. 20 years during the seventeenth century to c. 26 years by 1750-80, which meant that by the latter period ordinary Londoners had attained life expectancy levels enjoyed by Britain's royal families a century earlier. Even among the relatively well educated, prosperous and typically abstemious Quaker families living in London towards the end of the eighteenth century, life expectancy at birth is estimated to have been only 28 years.[41] By that time the royal family had gained a 20 year mortality advantage over Middle class Quakers, and, as has been noted previously, a still larger one vis-à-vis the London poor. Signs of an accelerated middle class catch-up would not become evident until well into the nineteenth century.

When life expectancy at birth for England's (urbanized) royals is compared to those for England's predominantly rural residents, however, the picture that emerges is quite different, which is to be expected inasmuch as the local disease environments of the two populations are not being held constant. In the 1600s the royal family had a marked life expectancy at

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1549-1650 (24.4 years), and those born in 1600-1699 (28.1 years) , and in 1649-1750 (18.2 years) are in each case significant at the 1 percent error level. See further discussion in the text of DSP (2010), Statistical Appendix section A.1.

[39] See DJP (2010), Statistical Appendix Tables A1.3 and A1.4 for summary results of Kolmogorov-Smirnov tests of the inter-cohort differences in 5-year survival distributions. These tests ask whether it is possible to reject the hypothesis that the two sets of mean age-specific survival rates (for the indicated pair of cohorts) are drawn from a common underlying mortality structure. Although, as noted in the text, the e_0's is found to be a sufficient statistic in this context, there are some notable variations in the details of the K-S tests. The 1500- 99 and 1700-99 survival distributions for royal males are significantly different at the 2.5% error level, and the differences between the 1700-99 and both the 1600-99 and 1649-1750 cohorts' distributions were more strongly significant. In the case of the royal females, the 1500-99 vs 1700-99 difference in survival rate distributions is significant at the 5% error level, whereas the comparison of the 1700-99 distribution with those for the 1600-99 and 1649-1750 cohorts shows differences that are significant at the 1% error level.

[40] It is not possible to give error bounds for the differences between the British royals' mean life expectancies at birth and those for Europe's ruling families, because no standard deviations for the latter were presented by Peller (1965). But, in view of the much larger sample sizes for the century long birth cohorts of European elites (see the notes to Table 1), there good ground for supposing that the pooled standard deviations employed for the inter-cohort tests reported among the ruling family members in Britain (detailed by DJS 2010) would be far smaller than those calculated from the British data alone.

[41] See Landers (1991:25). Buer's (1926) history still offers the most detailed, disease-specific account of how a series of medical campaigns and public health reforms initiated in the 1700s began to improve access to health care for ordinary people

birth *disadvantage* when compared to ordinary county people, who, simply by virtue of being rural, enjoyed a lower exposure to epidemic diseases and polluted air and water.

To the extent that the incidence of maternal mortality differentially abridged the lives of adult women, there are grounds for supposing that parity of survival rates between royal adult males and their counterparts in the country parishes would not have been achieved until the former clearly were outliving the adult men and women of those rural villages.[42] In any case, that was not long in coming, for adult life expectancy among the urban-dwelling royal males of the 1600-1700 birth cohort rose markedly, pushing their mean age at death above 64, well above of that typical among country-dwelling commoners.[43] Apparently, being based in London for much of the year no longer imposed a heavy mortality penalty on men in the royal families.

Could this have simply been due to the early winnowing of all but the hardiest from the ranks of the royal males? Because so few of the males in these families survived infancy and childhood (as seen from Table 4, only 42 percent of the birth cohort of 1600-1699, and 70 percent of the 1675-1749 cohort lived to celebrate their 5th birthdays), one might suppose that those who did so were exceptionally robust. What makes this suggested explanation for the increase longevity of the adults unpersuasive is that it cannot account for the increase from the level of adult expectation of life that had prevailed among the royal in the sixteenth century, when infant and child survival rates were no better (only 38 percent of the c.1500-1599 birth cohort reached age 25). Moreover, the view of the royal adult survivors of the latter part of the seventeenth century as selected hardy bunch is difficult to square with the fact that England's adult royal males of that era have been referred to as "the sickly Stuarts" by a medical doctor-historian, and with good reason.[44] The royal women were, if anything,

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[42] From Table 2 it is seen that at 57.4 years, these royal adult males' expectation of life (25 + e25) exactly matched the reconstitution parish average for men and women combined. But female mortality rates were systematically well above those for males throughout the age range from 25 to 44, due to the incidence of maternal mortality. The female mortality rate for ages 25-34 averaged 63 percent above that of the males in the period 1640-1809, according to Wrigley, Davies, Oppen and Schofield.(1997: Table 6.26, and pp. 302-03), who comment on the temporal stability of these sex-differential. On the other hand, after the end of the span of childbearing years, the female/male mortality ratio in the parish population rapidly declines from rough equality at age 45-49 – putting the men at a 36 mortality disadvantage by the time they reached ages 55-59. Thus, although partial life expectation estimates for those in the 25-65 age range (*Ibid*., Fig. 6.20, p.305) show a slight degree of absolute excess female mortality during the second quarter of the seventeenth century, the situation clearly was reversed throughout the second half of the century and remained that way during the 1700s, despite the persistence of excess female mortality in the 25-44 age range. So, it is not implausible to think that adult males rural parishes may have ceased to enjoy a survival advantage vis-à-vis their town-dwelling royal counterparts as early as the latter third of the seventeenth century.

[43] This can be seen by comparing the royal adult ages at death in DJP (2010), Statistical Appendix Table A.1.1b with the 26 parish estimates in Table 2, and referring to the discussion in the preceding footnote.

[44] See Holmes (2003). As patients, typically they were being treated for more than one serious medical condition. In the 1600s a series of books on life at court written by prominent doctors all agreed that irrespective of location, royal courts were unhealthy places, and "courtiers" themselves were particularly unhealthy people (Kummel, 1990). This would seem to have been a rather long-standing condition of Europe's princes. For example, Dr. Ann Carmichael (1989:p.34), after examining the extensive descriptive material on the individual health status of the Medici family (rulers of Florence in the 1400s and 1500s), concludes that "suffering mediated the lives of the Medici as much as it did the existence of their poorer, less advantaged contemporaries."

even less healthy, which may account for their still not achieving parity in survival rates with England's adult (mostly rural) women during the 1700s.

Finally, it should be noted that the apparent stability of royal male life expectancy at age 25 (see Figure 5a) should be interpreted with caution, because the underlying distributions of the ages at death rest on such small samples and therefore are so different in the two successive cohorts after that of 1600-1699. In that birth cohort of the eight males born to royal parents and surviving to age 25, only one lived past 70 years of age, and he was neither raised nor resident in England. By contrast, in the cohort of 1700-1799 there were 13 royal male survivors to adulthood, five of whom lived to be 70 years or older, but this remarkable longevity is masked in the cohort average by the others who died before their fiftieth year. The obvious point of caution to insist upon here is that as small as the entering sizes of these adult cohorts are, the numbers thin out quite drastically so the experience of a few long-lived individuals may be pulling up the average – or their absence may depress it substantially – hence the large standard errors associated with these means should continually be borne in mind.[45]

There are, however, some further facets of the quantitative evidence that serve to support and refine the foregoing generalizations, and these are best considered by taking the two aspects in turn, focusing first on the changing mortality of adult males and females in the royal families. A clearer view of the temporal changes that were taking place in the different portions of the age-specific schedule of mortality among the entire royal male populations is afforded by Figure 6(a), which displays estimates of the mortality hazard rates for each of the successive birth cohorts. These estimates are just the sets of age-specific mortality rate schedules of the sort one would find by constructing empirical life-tables for each birth cohort, were there a sufficiently large body of royal genealogical observations to permit such calculations to be made for 5-year age groups, let alone on a single year basis. Lacking that, DJP (2010) obtain the sets of estimates presented graphically in Figure 6 by statistically fitting the Anson (1991) parametric mortality model to the available cohort-specific distributions of survivorship, from whose estimated parameter values it is possible to retrieve the implied age-specific mortality hazard rates. [46]

Three features of Figure 6(a) are notable in connection with improvements in adult male mortality. First, the mortality rate schedule for those born in the 1600-1699 cohort drops persistently below that of the preceding (1550-1649) cohort most markedly in the 55-64 age range, and lies below it throughout the age range from 50 to 69. This locates the onset of the transition among the mature adult males in the latter half of the 17th century. Second, the movement towards elevated rates of survivorship among the royal males continues into the

[45] The methodology is discussed, and the observed and fitted age-group specific survival rates are shown, along with intercohort tests of significance in DJP (2010): Appendix A1, Table A1.

[46] The irregularities in the age-specific mortality schedules reflect those in the underlying cohort observations on ages at death, which are sparse (indeed non-existent) for some of the 5-year age groups. See Table A2.1a of the Statistical Appendix for the estimated coefficients of the 5-order polynomial regression model (Appendix eq. 4) fitted to the empirical age-specific survivor functions for each of the four birth cohort of royal males for which this procedure could be carried out. Figure A2.1a displays the actual and the fitted survivor functions. Corresponding details for the three cohorts of royal females are given in Appendix Table A2.1b, and Figure A2.1b. The irregularities in the age-specific mortality schedules reflect those in the underlying cohort observations on ages at death, which are sparse (indeed non-existent) for some of the 5-year age groups.

next century, as can be seen from the downward displacement of the schedule for the cohort of 1650-1749 which brought its level beneath that of the 1600-1699 cohort in the age range from 50 to 64. Third, the mortality transition among the royal males was essentially

Figure 6(a)

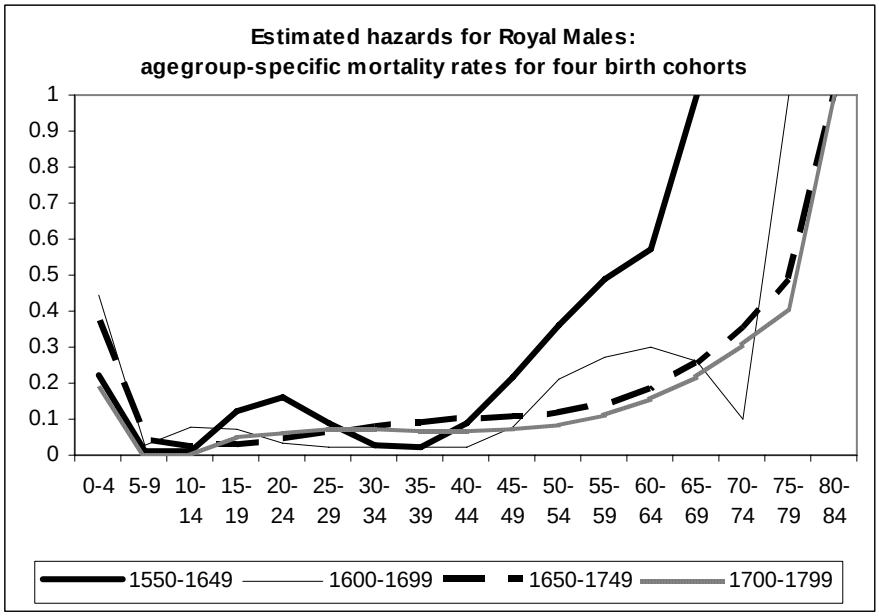
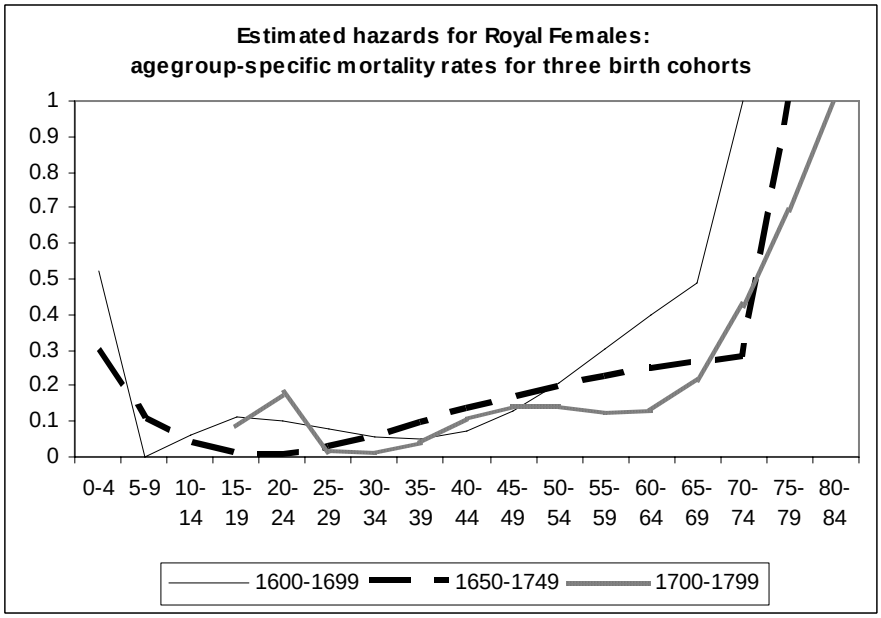


Figure 6(b)



Sources: See Statistical Appendix, Sect. A.2, for statistical parametrization of Anson's (1991) mortality model using royals' 'birth cohort-specific 5-year age group survival rates.

Notes: The right tail of age-specific mortality hazard rates plotted in Figures 5(a) and (b) is truncated in cases were there are no empirical observations of survivorship beyond the indicated age ranges. For males: the estimates stop with at 70-74 age-interval in the 1550-1649 cohort, at the 75-79 age interval in the birth cohort of 1600-1699, and also in the 1650-1749 cohort. For females: no estimated age-specific mortality hazards are shown in the plotted hazard rates in age groups 0-4, 5-9, and 10-14 of the 1700-1799 cohort, due to the absence in the underlying genealogical data of any recorded deaths at those ages.

completed by that point, as can be seen from the close coincidence between the hazard schedules for the cohorts of 1650-1749 and 1700-1799 throughout the entire age span above 25.[47]

The Mortality Transition among the Kings and Queens

A brief concluding focus on the demographic history of the people occupying the very pinnacle of the ruling elite during these centuries proves to be quite illuminating. It is so because the circumstances and individual details of the lives of the 15 men and the 20 women who here are counted as Britain's 'kings' and the 'queens', respectively, are known far more completely than is the case for most of the others in the royal families, and therefore can provide an interpretive context that gives the demographer's measures a significance beyond that which (in the case of these small and select population samples) statistical analysis alone can impart.[48] Moreover, because the data for these groups relate to the evolution of the expectation of life among men and women who had to be married, and/or to come to the throne – even if not all survived beyond age 25, they serve to filter out the effects of the volatile swings in royal infant and child mortality and contribute a direct view of the impact of the changes in adult mortality rates on the expectation of life at birth.[49]

The upward trend in longevity among Britain's Kings in each of the successive birth cohorts after that of the long sixteenth century can be seen – From Figure 7(a) – to have raised e_{25} between the cohorts of 1550-1649 and 1600-99, and between the 1650-1749 and 1700-1799 cohorts. Thus, for the kings who survived beyond age 25 and escaped violent death, the average gain in longevity between the cohorts of 1550-1649 and 1650-1749 amounted to 17.4 years.[50] The contrasting experience of the queens should then be noted

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[47] Table A2.2 of DJP(2010) presents the results of non-parametric (Kolmogorov-Smirnov) tests for differences between the empirical distributions of survival rates for all the royal males in various pairs of birth cohorts. Only the difference between the 1500-1599 and 1700-1799 birth cohorts is found to be significantly different, at the .05 level of error. Similarly, Table A2.3 reports a slightly stronger result for the difference between the males in the 1700-1799 birth cohort and in both 1600-1699 and 1650-1749 cohorts – both pairs being significantly different at the 0.025 level of error. The results of all the pair-wise K-S test results that were carried out are reported in DJP (2010): Statistical Appendix Tables A1.2a and A1.3a. indicate that the *entire schedule of mortality rates* are not found to be statistically different for the pairs of Cohorts 1550-1649 vs.1600-1699, and 1600-1699 vs.1650-1749 that are discussed in the text above in connection with the reductions that were occurring in the mortality rates of mature males. Only after the fall in royal infant and child mortality had taken place in the latter 1700s, do comparisons between the survival distributions of the 1700-1799 birth cohort and earlier cohorts show differences that are statistically significant. The latter point is emphasized in the text (below), as it is particularly germane to second aspect of the royals' mortality transition.

[48] That is not to say, however, that it is pointless to conduct and report formal tests of the statistical significance of inter-cohort differences in expectations of life for these sub-populations within the royal families. Quite the contrary, as will be noted below in reference to the statistically significant difference found between the mean age of non-violent deaths of the Kings belonging to the 1550-1649 and the 1700-1799 birth cohorts – a 17.4 year gap – as reported by DJP(2010): Statistical Appendix Table A1.4b.

[49] It is perhaps worth emphasizing that the interest here is in the *changes* in these conditional expectations of life, rather than in their levels. The conditions for becoming a King (i.e., a monarch proper) generally imply that there will be some upward selectivity bias in the resulting average levels of longevity, even among those who attained age 25 (and subsequently escaped a violent end): typically, one must wait for a father or uncle to die.

[50] DJP(2010):Statistical Appendix Table A1.4b, report the increased longevity between those in the birth cohorts of 1550-1649 and 1650-1749 was sufficiently big to be statistically significant at the 0.025 error level.

(from Figure 7(b)): here the inter-cohort increases of the average age at death are much more modest throughout the entire two-century-long period, and that was the case *a fortiori* for the sub-population that survived beyond age 25. [51]

Thus, in the 1700s surviving to old age became the norm among Kings. From the birth of Henry III in 1207 to the birth of George I in 1660 *none* of England's *titular* male sovereigns (a category excluding heirs apparent and royal spouses) lived long enough to reach 70 years of age. In contrast, of those British sovereigns who *reigned* in the 1700s and early 1800s, three out of four survived to reach 70 or more years. But, comparing kings and queens it appears that reaching 70 years of age became normal for kings about a century before it was the case for queens.

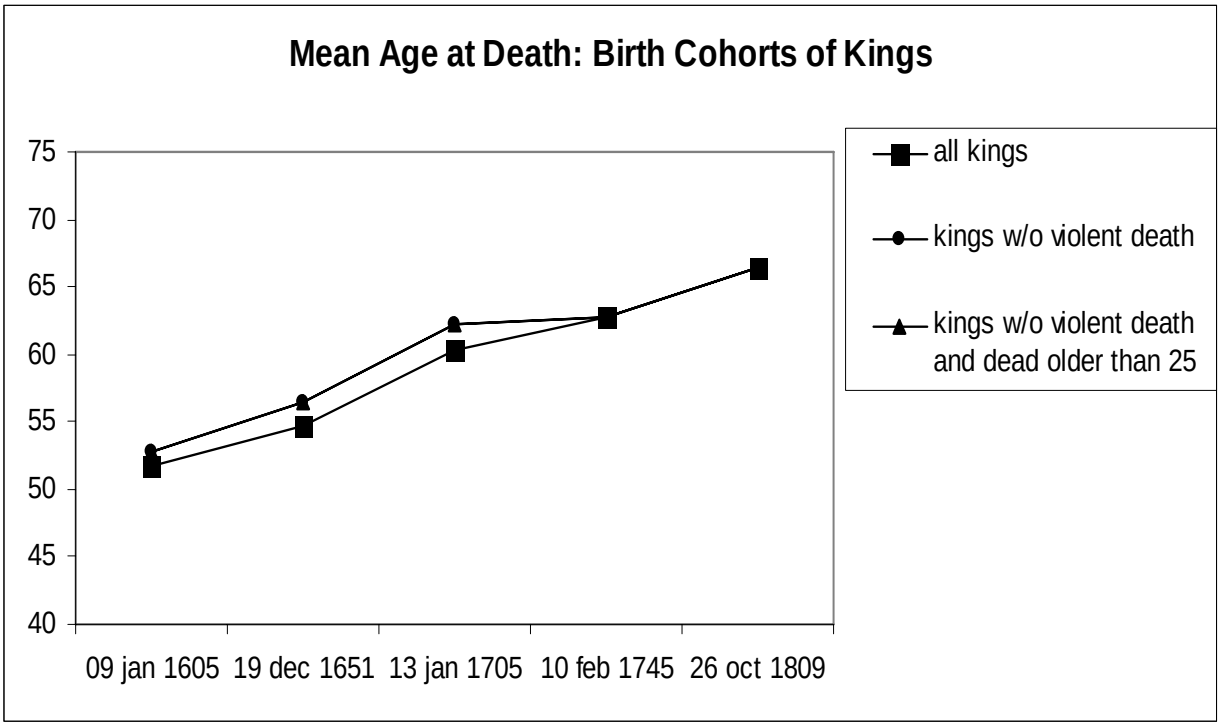
For people living in England, dying in old age did not become demographically normal until the mid-twentieth century. Among the 'queens' – a category, which it will be recalled, here includes all royal spouses, whether or not they formally held the title Queen – of those born after 1200 and before 1700, none lived to be 70 years of age or longer, although Elizabeth I came close, having survived to 69. The wife of George III, Queen Charlotte (born in 1744), was therefore the first British queen who lived past 70 years.

From Table 3 the ages at death of England's kings during the centuries with which the preceding discussion has been preoccupied may be viewed in a broader and longer perspective. Doing so underscores the central observation that the mortality transition that was underway among the adult male members of the country's ruling elite during the 1600s really did represent a demographic discontinuity, a break from past experience. These century-long averages show no sign of a sustained rise in life expectancy (e_0) among the English kings born between 1200 and 1599. In contrast, among the titular Kings of France the cohort averages of age at death by century of birth had been drifting upwards steadily until the 1500s. This trend raised the possibility in one historical demographer's mind of an early medieval royal health transition that had been interrupted in the sixteenth century (Houdaille, 1972: 1132). Evidently, if there is any substance to that suggestion, it cannot comprehend the quite different prior experience of England's monarchs – who in that period were related by intermarriage to the Kings of France.

This result is found (from Table A1.4a) also to be the case for the slightly larger inter-cohort gain (19 years) averaged by all the Kings, not just those surviving beyond age 25. Measured from the level of the 1500-99 birth cohort, the gains in average longevity from birth are still larger, and they are statistically significant for the kings as a group, for those who escaped violent death and, starting with the 1650-1749 birth cohort, also for those who survived to ages above 25.

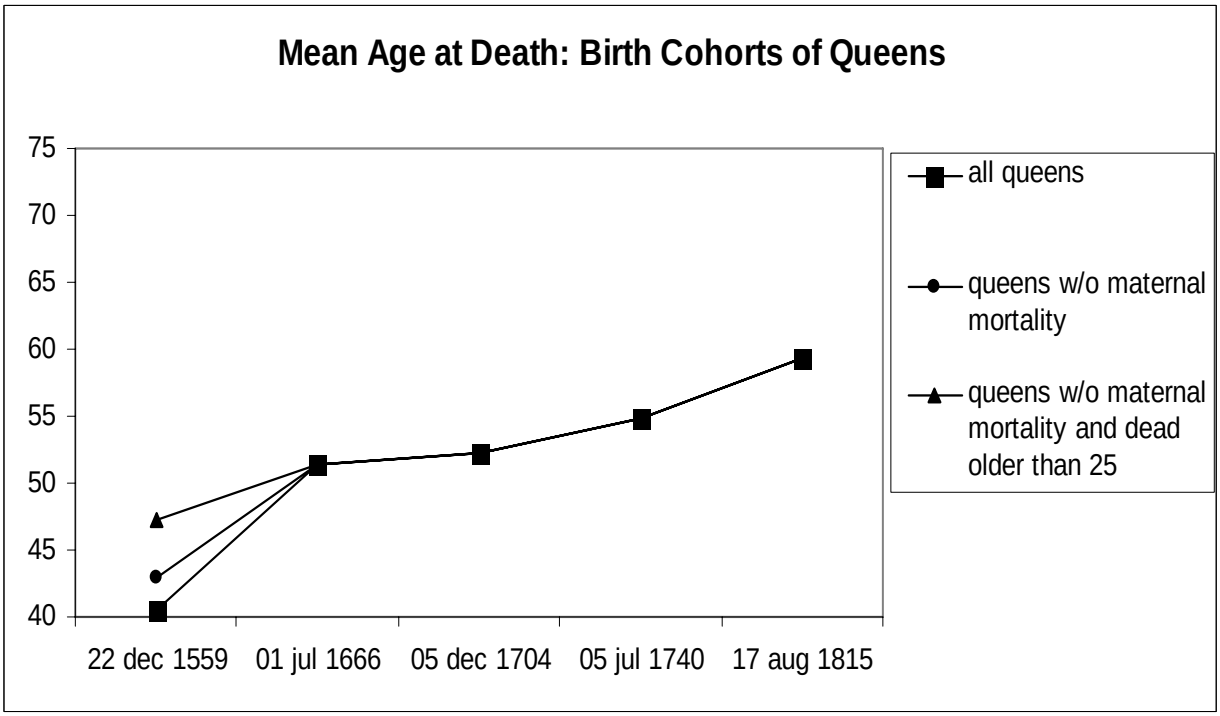
[51] Unlike the experience of the Kings (see fn. 25), only the approximate longevity gain of 21years that had accumulated between the cohort the 1500s and that of the 1700s in the case of the queens considered *in toto* is statistically significant; for those in the sub-group that survived age 25 and escaped maternal mortality, the average cumulative gain of 14 years is not significant at the 95% confidence level (as the one-tail t-test statistic, is 1.71, falling clearly short of the critical value of 1.83 (for df=9). See the tests of differences between Cohort 0 and subsequent cohorts in DJP(2010) : Statistical Appendix Table A1.3b.

Figure 7(a) Cohort-Specific Life Expectancies of Britain's Kings: Over-lapping century-long birth cohorts been c.1599 and 1799



Source: See Statistical Appendix: Table A1.2a, and text for definitions of 'Kings'.
Note: Means of age at death for each cohort are plotted at the cohort's mean death date.

Figure 7(b) Cohort-Specific Life Expectancies of Britain's Queens: Over-lapping century-long birth cohorts been c.1599 and 1799



Source: See Statistical Appendix: Table A1.2c, and text for definitions of 'Queens'.

Note: Means of age at death for each cohort are plotted at the cohort's mean death date

Table 3. Average Age at Death by Century of Birth: England's Kings compared to French and Japanese Rulers

(Number of individuals in Parentheses – Males only)

Century of Birth	England (& Scotland) [a]	France [b]	Japan: Emperors [c]	Japan: Shoguns [d]
1200s	**59** (3)	**41** (7)	**37**(12)	**41**(10)
1300s	**42** (7)	**44** (5)	**50** (9)	**43** (8/6)
1400s	**34** (8)***46**(5)	**50** (5)	**51** (5)	**32** (6)
1500s	**51** (4)†**56**(1)	**35** (5)	**68** (3)	**47** (6)
1600s	**61** (7)	**59** (2)	**50** (5)	**53** (5)
1700s	**74** (4)	**65** (5)	**41** (6)	**46** (5)

***Sources*:** England (Weir, 1996), and entries from Statistical Appendix Table A1.2a, rounded to the nearest integer; France (Wenzler, 2001); Japan (*Kodansha Encyclopedia* (1983), vol. 2: pp. 202a-203b).

Notes: (a) Before the 1500s only the *English* Kings are included in the series, which also contains both royal spouses and *heirs apparent* – or males who would have become king had they not died before reaching their majority.

(a*) Several heirs apparent are present in the entry for the 1400s and their removal substantially raises the mean age at death. For the '1500s', and the subsequent centuries, entries in this table follow the conventions adopted for designating nominal 'kings', which are mentioned in the preceding text and described in greater detail by Statistical Appendix A1 (see esp. ftnts 5 and 6 therein). (a†) The main entries in this series therefore correspond to those found in Appendix Table A1.2b, and for the 1500s they include King James VI of Scotland, on the ground that he subsequently wore the English crown, and because the "long sixteenth century" cohort (0) has been defined (for other reason) as ending in 1606, therefore closed after the Act of Union (1603). For backward comparison with the English Kings represented in the averages for the 13th through the 15th centuries, the alternative mean age at death is entered for the one properly English King born the period covered by Cohort (0): Henry VIII (born in 1491).

(b) Heirs apparent are not included in the French genealogical data consulted for France.

(c) Japan's emperors were hereditary "rulers" with priestly functions who lived their materially, privileged lives in relative isolation. Nevertheless some emperors in the list died very young and were included in the series, as the equivalent of heirs apparent.

(d) Japan's shoguns were more like European kings, because they were both military and political rulers. In the 1300s there were 8 shoguns, but the necessary birth/death date information is available only for 6 of them. Until c. 1600 the level of internal warfare was high, which increased the risk of violent death. Subsequently, under the Tokugawa Shogunate, peace was maintained but nevertheless a few of the listed shoguns died young.

But, after the 1500's, similar trends emerged in the expectations of life at birth for the kings in these two countries, and the average levels of e_0 became firmly established in the range above 60 years. This suggests that focusing attention upon the experience at the uppermost stratum of the western European elites has revealed a systematic demographic change and not simply the accidental consequences of random variations in mortality that allowed a small number of rulers to survive to uncommonly old ages. The additional comparisons with Japan's Emperors (the ceremonial rulers) and Shoguns (the military or political rulers of the country), afforded by Table 3, provides reinforcement for that suggestion: these series do not show any sign of a sustained rise in the average age of death during the seventeenth and eighteenth centuries, or for that matter even in the early 1800s. One may simply note the contrast with the experience of European rulers and Britain's Kings, in particular, and, recalling the chronicle of advances in medical knowledge and clinical care of uppermost strata of Britain's elites presented in section 3, observe the coincident fact that the medical care received by Japan's emperors did not become "Westernized" before the closing quarter of the nineteenth century – following the Meiji revolution and the end of the Shogunate.[52]

Returning now to consider the lot of Britain's Queens, and to the phenomenon of excess female mortality in adulthood that has been noted previously, it should be noted (from the comparison of Tables 7a and 7b) that for married queens of England, which is to say all the female adults save Elizabeth I, it was "normal" to die before their husband. If one excludes those marriages in which the King had taken a second or a higher-order wife – and therefore might be expected, on average, to have outlived at least one of them, the male-female differences in mean ages at death remain arrestingly large. Out of ten married pairs, beginning with Henry VII (b. 1457) and ending with William IV (b. 1765), only two royal wives outlived their husbands – and in one of the two marriages the King (Charles I) met a premature death on the Executioner's block. These male-female mortality differences averaged 11 years in the cohort of the 1500s, widened to 17 years in the cohort of 1650-1749 and then settled back at 13 years the cohort of 1700-1799 – large enough, surely, to call for some explanatory comment rather than dismiss it on the grounds that the numbers are too few for these to be of significance in the statistical sense. Actually, the latter surmise would be found untenable in the case of the kings and queens of the 1650-1749 birth cohort. [53]

To explain this phenomenon on the grounds that their biological difference left married women exposed to differentially greater risks of pre-mature death, however, is not so straightforward a matter. Although maternal mortality does appear to have been a major cause of premature death among these privileged women as late as the 1500s,[54] from the

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[52] See notes to Table 3 (below) for the source of the data for Japan. Although Western European medical ideas were introduced to Japan as early as the 1700s, Japan's doctors were hostile to the new medicine, and in 1849 it was forbidden by law to publish any more Western medical texts, with the exception of those dealing with surgery (see Fujikawa, 1934: p. 83).

[53] Compare the e_0 entries (average ages at death) in DJP (2010):Statistical Appendix Tables A.1.2 for all the "kings", with those for all the "queens."

[54] In the latter part of the fifteenth century, of the seven royal women who were married to Tudor monarchs three died giving birth, including the wife of Henry VII, and two wives of Henry VIII. Among Henry VIII's six wives, his third died giving birth, as did the last wife in the sequence – who had remarried after being widowed by Henry's death.

1600s through the 1700s no queen of England died in childbirth despite the continuation of very high fertility rates.[55] Thus, among the cohorts born between 1600 and 1749, even though maternal mortality had ceased to be a cause of death among married queens, they continued to die long before their husbands – at an average age of 52.[56]

There is reason to suspect frequent pregnancies, rather than maternal mortality *per se*, were the culprit – or at least a major causal factor – in the persistent excess adult mortality observed among England's queens. Extended pregnancies themselves can take a toll even when live births do not ensue. In the past no less than in the present, the state of pregnancy temporarily suppresses a woman's immune system, and compromises her body's natural capacity to fight disease. Moreover, delivery of a still-born infant, like that of a live baby, might leave in its wake serious cervical, uterine and bladder damage that could compromise her health.

To consider the risks of pregnancy it is necessary to know more about the queens' histories than the chronology of their live births, from which it appears that royal fertility rates on average were quite moderate during the 1600s, averaging 4.6 live births per queen. The dispersion around that mean was so large, however, that the average for this small sample is particularly deceptive: only one queen among the four came even close to realizing that average. Indeed, more typically, royal wives in this epoch either had borne more than six live infants (closely spaced) or none at all. Moreover, among the chronicles of the lives of those nulliparous royals wives one finds records of multiple stillbirths and miscarriages.[57] Queen Anne is recorded in the genealogy of the royal family to have been delivered of five live infants, but she endured 13 other pregnancies that ended in a stillbirth, as well as one observed miscarriage. Frequent pregnancies including stillbirths – of which there were in all 26 to England's "queens" in the 1600s, half of them being those to Queen Anne–therefore may well have damaged the health and contributed to shortening the life span of these otherwise economically and socially privileged women.

Thus, being able to consider these women's histories of pregnancy, rather than simply focusing upon measures of live births and the hazards of childbed mortality, permits the emergence of a clue to the differences in male-female longevity, beside those seen between the kings and queens. This explanatory hint may be no less germane to understanding the source of the statistically significant 14.9 year gap that has been observed between the average ages at which adult males and females from the entire royal birth cohort of 1600-

[55] There is one close case. The first wife of James II died in 1671, while her husband was still heir apparent. She died 42 days after giving birth, but contemporaries blamed her death on an advanced case of cancer, not childbirth.

[56] In the l700s no queens or queens apparent died in childbirth, or even up to a year after giving birth. For another royal maternal death historians must look to the daughter of George IV, Princess Charlotte Augusta, who died giving birth in 1817. By that time maternal mortality among queens/princesses was considered so medically avoidable, that the presiding physician (one of three attending) was criticized for incompetence and killed himself.

[57] As there are no signs of deliberate fertility control (in any sense of that term) among the royals families before the twentieth century, declining pregnancy rates cannot be though to have contributed to the slightly longer lives led by royal women in the 1600s or 1700s. In Peller's data (1943: 436) there was very little difference between the death rates of women who were childless or fertile. But those eventually married royal women who remained single into their 20s and 30s had lower death age-specific death rates than their already married royal counterparts.

1699 were dying – even when the men escaped violent deaths and the women did not die in childbirth.

The long-standing pattern of excess female (adult) mortality among England's queens continued among the eighteenth century royal birth-cohort – albeit in a somewhat attenuated form – before it come to an end abruptly with the reign of Queen Victoria. She survived to age 82 – her nine pregnancies notwithstanding, and the wives of Edward VII and George V (also born in the 1800s) similarly survived into a ninth decade, dying at ages 81 and 86 respectively. So, living into advanced old age became the norm for Britain's queens born in the nineteenth century, whereas, as has been seen, this norm had already been attained by the kings born in the preceding century.

The Mortality Transition among Royal Infants and Children

Looking back at the graphs of the mortality rate schedule for successive royal birth cohorts in Figures 6(a) and 6(b), one should now take note of a fourth feature, additional to the three upon which the preceding discussion commented explicitly. This is the downward shift of age-specific hazard of mortality that appears at the lowest end of the age range; and which was mainly responsible for the statistically significant difference between the schedule of age-specific survival rates experienced by the birth cohort of the 1700s and by the preceding cohort overlapping with it (i.e., those born during 1650-1749). A fuller and more detailed view of the timing and extent of these changes in royal infant and child mortality, and of their relationship to contemporaneous developments in the English population at large will be gained by looking at the entries in Table 4.

From these estimates it is evident that English royal expectations of life at birth for males and females were so very low during the sixteenth and seventeenth centuries primarily because their infant mortality and child mortality rates were so extraordinarily high. Taking males and females together, the combined mortality before age 5 averaged 639 per 1000 in the cohort born during the 1500s, and was not much lower (581 per thousand) in the birth cohort of the 1600s.[58] Deaths in infancy that occurred at rates in the range from 444 to 419 per 1000 accounted for most of these losses, as may be seen directly from the entries in the left-hand panel of the table. The contrast with the situation reflected in the English parish registers of the latter part of the sixteenth century and the seventeen centuries is striking indeed. For the commoners in the mostly rural parishes studied by Wrigley et al. (1997), the

[58] Were James II's many offspring to have been excluded from the royal birth cohort of 1650-1699, the average royal mortality rates for the rest of that cohort (i.e., Queen Anne's children) would be ${}_0q_1$= 428 (7 obs.) and ${}_1q_4$ = 500 (2 obs.) – not lower overall than the infant and child mortality rate implied by the rates given in Table 4. Queen Anne's pregnancy history was (painfully) unique in other respects, as the discussion of excess adult female mortality in the preceding sub-section has noted: she had 13 still-births (a still-born conception rate of 0.75!), whereas the corresponding rate for James II's two wives was 0.25.

Table 4. Infant and Child Mortality per 1000: Royals and Commoners, c.1500 – 1799

	Royals: (M + F) [a]				Commoners: (M + F)			
	Infant mortality per 1000		Child mortality per 1000		Infant & Child mortality per 1000: Urban parishes [b]		Infant & Child mortality per 1000: All 26 parishes [c]	
	$_0q_1$	*no. obs.*	$_1q_4$	*no. obs.*	$_0q_1$	$_1q_4$	$_0q_1$	$_1q_4$
1500 - 1599†	444	*36*	200	*16*	n.a.	n.a.	n.a.	n.a.
1500-1549	467	*30*	125	*16*	n.a.	n.a.	n.a.	n.a.
1550-1549	333	*6*	500	*4*	236	115	169*	87*
1600 - 1699	419	*31*	278	*18*	239	133	172	100
1600-1649	222	*9*	143	*7*	229	121	164	91
1650-1699	500	*22*	364	*11*	250	145	179	109
1675 - 1749	242	*33*	80	*25*	270	149	193	112
1700 - 1799	29	*35*	59	*34*	244	146	175	110
1700-1749	58	*17*	0	*16*	266	152	191	115
1750-1799	0	*18*	111	*18*	223	140	160	106

Sources: (**Cols. a**) Average infant mortality and average child mortality for male and females together are computed for each of the indicated birth cohorts from data underlying Statistical Appendix Tables A1.1b, and A1.c. The larger number of observations for births permits working with 50-year cohorts within each century and dispensing with the overlapping century-long cohorts employed for the analysis of adult mortality.

(**Cols. b**) These estimates are derived for all cohorts *save for that of 1675-1749* by adjustment of the $_0q_1$ and $_1q_4$ rates, respectively, for the 26 reconstituted parishes (in Cols. **c**), using the adjustment multipliers 1.396 (for $_0q_1$) and 1.328 (for $_1q_4$). The multipliers were computed as the ratios between the respective entries for infant mortality, and for child mortality, in the "urban parishes' (Cols.(b)) and those for "all 26 parishes" Col.(c). For the source of the col. (b) entries in 1675-1749, see the source notes for Col.(c).

(**Cols. c**) Wrigley, Davies, Oppen and Scofield (1997), Table 6.1 (p.215) give decennial averages for $_0q_1$ and $_1q_4$ from 1580-89 through 1790-99, which were arithmetically average to obtain the rates corresponding the intervals defined in this table for the royal birth cohorts. From Table 6.16 (*Ibid.*, p.270) it is possible to obtain the all parish infant and child mortality rates for the period 1675-1749, and also to calculate the corresponding averages rates for 5 "urban" parishes that appears in Cols. c. This was done by first averaging the respective rates for the 4 urban places that were not low-lying (and hence less affected by malaria): Alcester (Warwicks.), Banbury (Oxon.), Gainsborough (Lincs.) and Lowestoft (Suffolk). Their average rates for $_0q_1$ and $_1q_4$, respectively, were given a weight of 2/3 and combined with the mortality rates for March (Cambs.) the single low-lying urban parish in the sample of 26, and the one having the highest rates of infant and child mortality.

Notes: (*) Averages of decadal rates for 1580-89, 1590-99, 1600-09.

() Cohort dates run from 1485 through 1606, as explained in Appendix section A.1.

right-most pair of columns in Table 4 indicate that mortality rates for male and female infants combined ($_0q_{1,\ M+F}$) averaged in the range from 169 to 179 per 1000 over those two

centuries.[59] The corresponding average child mortality rates ($_1q_{4,\ M+F}$) lay in the range from 87 to 109 per 1000.

The magnitude of these differences is startling, and much exceeds what might be supposed to be the result of contrasting the common lot of English babies born in rural settings with their town-born counterparts. An attempt to gauge the effect of that differential is offered in the columns of Table 4 headed "Urban Parishes." The measured differences (during the period 1675-1750) between 5 urban parishes within the group of 26 reconstituted English parishes, is drawn from the work of Wrigley et al. (1997) as the notes to the table explain, and the proportional urban differentials have been applied to provide corresponding "urban-adjusted" average rates of infant and child mortality for all of the 50- and 100-year time periods from the mid sixteenth century to the end of the eighteenth century. The result when the infant mortality rates in the royal family are compared with the corresponding "urban-adjusted" rates in the 50-year intervals between 1550 and 1650-99, is that the latter are found to be about 47 percent higher. Performing the same calculation based on the two series of child mortality rates reveals that the gap between the royal child mortality rate and the "urban-adjusted level" in the country parishes was 94 percent, almost twice that for infant mortality. If differences in disease environment mattered, these differentials offer an implicit measure of the extra-lethality for the youngest among the royal families of the London environs – compared with town-life elsewhere in the realm.

Against this background, it can be seen that the dramatic gains in average life expectancy at birth enjoyed by the London-based royal families in the eighteenth century's birth cohort are attributable largely to the spectacular post-1699 decline that occurred in the average mortality rates among their infants and children. Peller's (1965) figure for the child mortality rate (172 per 1000) for the European ruling families during the 1700s, is almost three times higher than the average rate of 60 shown for Britain's royal families during the eighteenth century. Thus, in this aspect of their mortality transition as in others, the elites in Britain were ahead of their continental counterparts, and this movement paralleled the lead that the royal families had taken in accepting the management of infant care and, probably more significantly, the inoculation of their children against smallpox.

What can be said more definitively is that the marked reduction of royal infant and child mortality among the eighteenth century birth cohorts cannot be reasonably ascribed to the royal households' practice of regularly fleeing the city for refuge in more salubrious rural surroundings? For English royalty, seasonal withdrawals to country palaces and castles had been a practice of much longer standing, and by the eighteenth century most urban-dwelling gentry customarily retreated from the city to the country during the summer months. But, the important point to note is that when royals took up residence in country palaces they brought with them significant elements of the Metropolis' high-exposure disease environment. By the sixteenth century Europe's royal courts, and the English court no less, were major institutions employing hundreds and sometimes thousands of people. Foreigners, soldiers, trades-people, servants, craftsmen and laborers came and went. When they arrived, the pathogens of

[59] The underlying English parish register data implies that infant mortality rates averaged over a range of 148-195 per 1000 for males, and 132-163 per 1000 for females, depending on the parish.

diseases prevalent in the metropolitan environs where they normally dwelled and worked, or that of the towns and ports through which they had passed, arrived along with them.[60] It is not surprising, then, that Razzell (1999) has found that during the 1600s the chances of a royal infant born in England surviving its first year of life was much the same for those in urban and in suburban palaces.

Most ordinary English babies had the advantage of being both rural born and breastfed by their own mothers. Royal babies also were breastfed, but throughout most of this period this was done by wet nurses hired for each child and not by their mothers. How much of a mortality disadvantage this practice imposed is not known, if indeed it imposed any disadvantage at all. Although royal wet nursing continued into the eighteenth century, the exceedingly high infant and child mortality rate of the preceding centuries nevertheless gave way to an average level of ${}_0q_1$ that was astonishingly low: only one among the 35 babies born to royal marriages during the 1700s failed to survive its first year, a rate of 28 deaths per 1000. Further, the entries in Table 4 imply a combined infant and child mortality rate that averaged only 86 per thousand for royal births during that century.[61] Still more remarkable is the fact that during the first half of the eighteenth century no infant deaths were recorded in the royal family, nor during the second half were there any child deaths. The part that was played in this by managed care of infants with increasing medical supervision of the health of wet nurses, and the growing fashion among the mothers in aristocratic households of nursing their own babies immediately after the birth, remain to be established. But, unfortunately – for historical researchers, though not for their subjects in this case – the virtual disappearance of infant and child deaths among this elite population has removed the opportunity to shed light on the causes by careful differential analyses of the circumstances in which some perished while others survived.

The Demographic Evidence: A Summing Up

The life expectancy history displayed by Peller's continental royals resembles that of Britain's royal family. But for this particular ruling family there had been a faster transition to higher levels of life expectancy at birth from the 1600s through the 1700s, partly because of the faster decline of infant and child mortality rates that took place in eighteenth Britain. England's royal adults did better than most of their continental royal counterparts, although the French were not far behind.

That a sustained royal transition to higher life expectancy levels did not begin before the 1600s, either in England or in the Continent, was not for want of trying. Long before the 1600s, Europe's ruling families did what they could to preserver their health and postpone death. In the early middle ages both popes and monarchs supported the study of medicine at

[60] See Hecht (1956) on domestic servants' part in transmitting disease from the urban to the country residences of the London-dwelling gentry and aristocracy during the 18th century.

[61] Of 34 live births to five royal marriages during the 1700s, only 1 baby died in infancy, and there were two other child deaths. Including the birth of a child to a royal princess who was married to the adult heir apparent adds nothing to the totals of infant and child deaths. The latter are reflected in the rates in Table 4. Note that Hollingsworth's aristocrats did not do quite as well as the royal family in this respect until the first quarter of the 19th century.

the university level (Siraisi, 1992). Subsequently they hired and handsomely rewarded those physicians and surgeons who were perceived (legitimately or not) as being the most efficacious in their profession. Perceived medical efficacy became very profitable long before we have any evidence that it reduced royal death rates (Digby and Johansson, 2003).

Although royals themselves were not generally educated at universities, they could all read and write by 1500, if not earlier. In contemporary social science research, literacy not only increases access to knowledge, but receptivity to it as well, along with greater willingness to follow medically legitimized advice (Zimmer and House, 2003).

Despite a plethora of long standing economic and social advantages, *advantages already in place by the 1500s,* royal life expectancy stayed low. But by the late 1600s, after a surprising amount of useful, health-related knowledge had been produced, adult royal life expectancy showed signs of increasing, despite continuing urbanization. Royal adults were first to benefit. Once innovative physicians began to publish research on the diseases of infants and children, death rates for young royals began to fall in the early 1700s.

Giving historical significance to these trends depends on finding a plausible explanation for them. In this case there is empirical evidence that the surprisingly early royal and elite rise of life expectancy was as a consequence of responses to the accelerating growth of useful "medical" knowledge related to the prevention, management or cure of various diseases that were perceived to be prevalent and deadly in early modern Europe.

Concluding Observations

This article has used royal mortality data from Europe in the 1500s, 1600s and 1700s, as if it were a natural experiment designed to illuminate the key role played by useful knowledge in initiating the modern rise of life expectancy. Because royal lives were rarely, if ever, troubled by caloric insufficiency, what these economically and socially privileged families needed in order to live longer lives was more useful knowledge about the diseases that killed them so early and often. Increasingly, as the useful knowledge they needed was created and disseminated among an elite of the medical practitioners beginning in the 16th century, the life expectancy of those who sought and could afford their services began to increase – not among all members of the royal families concurrently, but following the internal status hierarchy that directed medical attention first to adult males.

It must be stressed that placing the explanatory emphasis on knowledge as the driving force behind rising life expectancy, as has been done here, does not imply that there were no Europeans whose lives were not cut short by the side-effects of poverty including caloric insufficiency and improper nutrition. The mortality matrix in Figure l is based on the assumption that, holding the local disease environment constant, higher incomes alone would have provided poor families with the means to raise their life expectancy levels by buying more food, better food, better housing, more fuel, or even more medical attention.

But Europe's materially privileged sub-populations, especially its royal families, would not have lived any longer by getting still richer. As late as the 1500s they remained knowledge-poor about the diseases that shortened their lives, and the only remedy for that particular kind of poverty was more knowledge. Thus when elite life expectancy levels began to rise after c. 1600, what is being observed is the force of useful medical knowledge at work, relatively unimpeded by economic or social barriers that blocked accessibility to that knowledge.

The fact that Europe's elites could afford to pay a high price for the latest medicine provided a critical form of financial support for continuing medical innovation, much of it directed to the conditions prevalent among the clients of the doctors who served the most privileged strata of elite society. This was the case especially during the three centuries before 1800, when formal medicine as taught at the university level, was more likely to discourage innovation than encourage it.

Those monarchs who hired physicians famous for their achievements in anatomy, were in effect funding basic research long before it could be used to treat, manage or cure any particular disease. The kings who hired physicians and surgeons with a reputation for practicing the newer forms of medicine insured that innovative physicians could be successful, despite opposition from powerful medical conservatives. It is conceivable that without monarchical patronage, and elite consumers, European or "Western" medicine might never have evolved so quickly into the vast scientific enterprise it eventually became.

But the history of elite medicine has its dark side. Those European monarchs who bought the best medicine for themselves in the 1500s, 1600s and 1700s did so for selfish reasons, either to save their own lives, or enhance their prestige. The initial effect of their support was to create more pronounced forms of life expectancy inequality, *especially within urban disease environments.* But in England and Wales what became a level of life expectancy fit

for an urbanized king at the end of the 1700s, became that urbanized nation's life expectancy at birth level by the end of the 1800s – largely, it is true, through the progress made in scientifically informed public health measures. By that time, of course, the upper classes had moved on to still higher levels of life expectancy (c. 60 years in 1900) but these high levels had also became "nationalized" by the 1950s, a mere half century later.

Today, global life expectancy at birth is estimated to be in the high 60s, despite the existence of millions of poor people and their malnourished children who are still coping with food insecurity. Compared to the past, even the contemporary poor live in a knowledge-rich environment, where they have partial access to a large stock of useful medical knowledge. Depending on specific medical and public health policies adopted at the national level, and, more importantly, actually delivered at the local level, even poor, chronically malnourished people can attain life expectancy levels once fit for kings. If the world's poor had equal access to the entire stock of useful knowledge now available they would undoubtedly live years longer than they now do (Easterly, 2006). More than ever, global life expectancy is a matter of political will.

Yet, as long as useful knowledge keeps being produced and relative wealth insures early access to its applications, we can predict that life expectancy inequality between classes and countries will persist, and the wealthiest sub-populations will preserve what has become by now a centuries old mortality advantage. Equality of access by individuals to good personal medical care becomes increasingly important in narrowing social differentials in longevity in developing countries as chronic diseases replace infectious diseases as leading causes of death. Consequently, whether or not life expectancy inequality between rich and poor will increase or decrease globally in the coming decades will depend on the extent to which health policies alone, in the face of continuing economic and social inequalities, can be effective in promoting more egalitarian access to the applications of advanced medical knowledge.

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References

Adler, R. 2004. *Medical Firsts From Hippocrates to the Human Genome*. John Wiley & Sons, Inc. Hoboken: New Jersey.

Antonovsky . A. . "Social class, life expectancy and overall mortality. *Milbank Memorial Fund Quarterly,* 45: 31-72.

Backs, J. 2001."Mortality in Ghent, 1850-1950. A social analysis of death." In, *Recent Work in Belgian Historical Demography: 19th and early 20th centuries.* Edited by I. Devos, and M. Neven. (A Special Issue of Belgisch tijdschrift voor nieuwste geschiedenis, 31: 538-50.

Berkman, L,& M. Glymour 2006. "How society shapes aging: the centrality of variability" *Daedalus. Journal of the American Academy of Arts & Sciences.* Winter 105-114.

Blum, A. 1990. "Mortalité différentielles du XVIIe au XIXe siècle, espace and société. *Annales de Démographie Historique* 1990: 14:22.

Blum, A. J. Houdaille, M. Lamouche . 1990. "Mortality differentials in France during the late l8th and early 19th century" *Population* (English Selection) vol. 2: 163-186.

Bourdelais, P. 2000. L, inégalité sociale face a la mort: L'invention récente d'une réalité ancienne." In. *Les Inégalites socials*. Edited by A. Leclerc, D. Fassin, H. Grandjean, M. Kaminski, T. Land. Inserm-La Découverte: 27-39.

Bourdelais, P. 2003. *Les épidémies terrassées.* Darantiere: Dijon-Quetigny

Bovey, A. 2005 *Tacuinum Sanitatis. An Early Renaissance guide to Health.* London: Sam Fogg.

Bown, S. 2003. *Scurvy. How a Surgeon, a Mariner and a Gentleman Solved the Greatest Medical Mystery of the Age of Sail*. New York: St. Martin's Press.

Brewer, C. 2000. *The Death of Kings.* London: Abson Books.

Brockliss, L and C. Jones. 1997.*The Medical world of Early Modern France.* Oxford: Clarendon Press.

Buer, M.C. 1926. *Health, Wealth and Population In the Early Days of the Industrial Revolution,* London: George Routledge &Sons Ltd.

Caldwell, J. 1990. "Introductory thoughts on Health Transition" In, *What We Know About Health Transition. The Cultural social and Behavioral Determinants of Health*. Edited by J. Caldwell et. al. Canberra: Australian Printing Service.

Carmichael, A. 1989. "The Health Status of Florentines in the Fifteenth Century." In *Life and Death in Fifteenth-Century Florence.* Edited by M. Tetel, R. Witt, and R. Goffen. Durham: Duke University Press.

Chesnais, J. 1992. *The Demographic Transition. Stages, Patterns and Economic Implications*. Oxford: Clarendon Press.

Clendening, L. (ed.) (1960) *Source Book of Medical History*. New York: Dover Publications Inc.

Coale, A. Demeny, P. 1983. *Regional Model Life Tables and Stable Populations*, 2nd Edition. New York; Academic Press.

Coleman, D. and Salt, J. 1992. *The British Population. Patterns, Trends and Processes.* Oxford: Oxford University Press.

Cutler, D. and Miller, G. 2005. "The Role of Public Health Improvements in Health Advances: the Twentieth Century United States." *Demography* 42: 2-23.

David, P. A. 2004. "Understanding the Emergence of Open Science Institutions; Functionalist Economics in Historical Context" *Industrial and Corporate Change* 13: 1-50.

David, P. A. 2008. "The Historical Origins of Open Science: An essay on Patronage, Reputation and Common Agency Contracting in the Scientific Revoultion", *Capitalism and Society,* v. 3 (2), November.[Available at http://www.bepress.com/cas/vol3/iss2/art5].

David, P. A., S. R. Johansson and A. Pozzi, 2010. "The Demography Of An Early Mortality Transition: Life Expectancy, Survival And Mortality Rates For Britain's Royals, 1500-1799," University of Oxford, Discussion Papers in Economic and Social History # 83.

De Brouwer, V. R. Tonglet and W, Van Lerberghe, 1998. "Strategies for Reducing Maternal Mortality in Developing Countries: What Can We Learn from the History of the Industrialized West?" *Tropical Medicine and International Health* 3: 771-82.

Demeny, P and G. McNicoll, 2006. "World Population from 1950-2000. Perception and Response" In, *The Political Economy of Global Population Change, 1950-2050.* A Supplement to v. 32 of *Population and Development Review*: 1-51.

Digby, A. and S. Johansson, 2003. Producing Health in Past and Present: The Changing Roles of Scientific and Alternative Medicine. *The Economic Future in Historical Perspective.* P. David and M. Thomas (eds.) Oxford: Oxford University Press for the British Academy. 439-462

Dobson M. 1997. *Contours of death and disease in early modern England*. Cambridge: Cambridge University Press.

Drexler, M. 2006. "The People's Epidemiologists" *Harvard Magazine,* 108, no, 4: 25-33.

Easterlin. Richard. 2004. *The Reluctant Economist: Perspectives on Economics, Economic History and Demography*. Cambridge: Cambridge University Press.

Easterly, W. 2006. *The White Man's Burden.* Oxford, Oxford University Press.

Elias, N. (1994 ed). *The Civilizing Process,* Oxford, Blackwell Publishers.

Everden, D.. 2000. *The Midwives of Seventeenth Century London.* NY Cambridge University Press.

Fabricius, J. 1994. *Syphilis in Shakespeare's England*. London: Jessica Kingsley Publishers.

Finch, C. 2006 “Aging, inflamation & the body electric” *Daedalus. Journal of the American Academy of Arts&Sciences. Winter*: 68-76

Fogel, R. 2004. *The Escape from Hunger and Premature Death 1700-2100: Europe, America and the Third World.* Cambridge. Cambridge University Press.

Fridlizius, G. 1984. “The Mortality Decline in the First Phase of the Demographic Transition: The Swedish Experience.” In *Pre-Industrial Population Change. The Mortality Decline and Short-term Population Movements.* (Eds.) Bengtsson, T, G. Fridlizius, R. Ohlsson. Stockholm: Alquist & Wiksell International. 71-114.

Fujikawa, Y. 1934. *Japanese Medicine.* New York: Paul B. Hoeber, Inc.

Furdell, E.L. 2001. *The Royal Doctors, 1485-1714. Medical Personnel at Tudor and Stuart Courts* . Rochester New York: Rochester University Press.

Guinnane, W. Sundstrom and W. Whatley (Eds) 2003. *History Matters. Economics, Technology and Demography.* 2003. Stanford: Stanford University Press.

Galloway, P. 1993. ” Short Run Population Dynamics Among Rich and Poor in European Countries, Rural Jutland and Urban Rouen” In, *Old and New Methods in Historical Demography.* (Eds.) D. Reher and R. Schofield. Oxford: Clarendon Press. pp. 84-108

Golub, E. 1994. *The Limits of Medicine. How Science shapes Our Hopes For the Cure.* New York: times books, Random House.

Greif, A. 2006. *Institutions and the Path to the Modern Economy. Lessons from Medieval Trade.* Cambridge. Cambridge University Press.

Gruman, G. 1961. “The Rise and Fall of Prolongevity Hygiene” *Bulletin of the History of Medicine* 35: 221-9.

Haeger, K. 1983. *The Illustrated History of Surgery.* Harold Starke: London.

Harvey, B. 1993. *Living and dying in England 1100-1540.* Oxford: Clarendon Press.

Hatcher, J. 1986. “Mortality in the Fifteenth Century. Some New Evidence” *Economic History Review* 2nd. Ser. 39:1938.

Hatcher. J. 2003. “Understanding the Population History of England, 1450-1750”, *Past and Present.* No. 180 pp. 83-130.

Hayami, A. 1997. *The Historical Demography of Pre-Modern Japan.* Tokyo: University of Tokyo Press.

Hecht, J. J. 1956. *The Domestic Servant Class in Eighteenth-century England*, London: Routledge & Paul.

Hecht, J. 2000. Demography and History: a Matter of Elective Affinities, in Z. Pavlik (ed.) *Position of Demography Among the Other Disciplines.* Prague: Charles University. Printed by CKD Sluzby. :95-106.

Hollingsworth, T. 1957. “A Demographic Study of the British Ducal Families” *Population Studies* 11: 4-26.

Hollingsworth, T. 1965. “The Demography of the British Peerage” *Population Studies* (Supplement) 18: 2-85

Hollingsworth, T. 1977. “Mortality in British Peerage Families Since 1600” *Population,* 32, Numero Special. 323-351.

Holmes, F. 2003. *The Sickly Stuarts. The Medical Downfall of a Dynasty.* Stroun, Gloucestershire: Sutton Publishing.

Houidaille, J. 1972, “Mortalité masculine dans les familles regnantes au Moyen Age” *Population,* 27: 1131-1134.

Isenburg, W. 1936-7. *Stammtafeln zur Geschichte der Europäischen Staaten*. Berlin: Stargardt.

Jeffreys, D.2005. *Aspirin. The Remarkable Story of a Wonder Drug*. New York and London: Bloomsbury Publishing.

Johansson, S. and C. Mosk. 1987 “Exposure, resistance and `life Expectancy`; disease and death during the economic development of Japan, 1900-1960.” *Population Studies* 41:207-235.

Johansson, S. 1991. “Welfare, mortality and gender. Continuity and change in explanations for male/female mortality differences over three centuries” *Continuity and Change* 6: 135-177

Johansson, S. Ryan. 1994. “Food for Thought. Rhetoric and Reality in Modern Mortality History” Historical Methods 27: 101-125. This is an extended critique of McKeown’s use of mortality data.

Johansson, S. Ryan. 1999. “Death and the doctors: Medicine and elite mortality in Britain from 1500 to 1800,”*Cambridge Group for the History of Population and Social Structure, Working Paper Series No. 7*. Cambridge University Press.

Johansson, S. Ryan. 2000. “Before the Health Transition: ‘Health’ and Health Policy in Victorian England and After.” *Annales de Demographie Historique* 2:109-132.

Johansson. S Ryan. 2000, “Macro and Micro Perspectives on Mortality History” *Historical Methods*. Special Issue, *Spatial Variations in Mortality.* 33: 2-34..

Johansson S. Ryan . 2003. “When Numbers Began to Count for Policy Purposes.” *Population and Development Review* 29: 715-730.

Johansson S. Ryan.2004.“The Pitfalls of Policy History. Writing the Past to change the Present” *International Journal of Epidemiology.* 33:

Johansson, S. 2005. “Fogel and the History of Mortality.” *Population Studies* 59: 247-253 .

Kearns, G. 1991. “Biology, class and the urban penalty” In, *Urbanising Britain: essays* … Edited by G. Kearns and C. Withers. Cambridge: Cambridge Univerity Press.

Kodansha Encyclopedia of Japan, 1983. Tokyo: Kodansha Ltd., Vol 2.

Kümmel, W. 1990. "De Morbis Aulicis: on diseases found at court", In, *Medicine at the Courts of Europe,* 1500-1837, edited by Vivian Nutton. London: Routledge. 15-48.

Kunitz,S, and S. Engerman. 1992. "The Ranks of Death and secular Trends in Income and Mortality" *Health Transition Review,* 2: 29–46.

Landers. J. 1990. *Death and the Metropolis*. Cambridge, Cambridge University Press.

Landers, J. 1991."London's Mortality in the 'long eighteenth century' a family reconstitution study." In, *Living and Dying in London.* Edited by W. Bynum and R. Porter. *Medical History,* Supplement No. ll.: l-28. See page 25.

Landry, A. 1934 *La révolution demographique.* Paris; Librarie du Recueil Sirey.

J. Lee, C. Campbell, W. Feng. 1993 "The Last Emperors: An Introduction to the Demography of the Qing 1644-1911." In, *Old and New Methods in Historical Demography.* (Eds.) D. Reher and R. Schofield. Oxford: Clarendon Press. 365-383

Lindberg, D. 1992. *The Beginnings of Western Science.* Chicago: Chicago University Press.

Livi-Bacci, M. 1991 *Population and Nutrition: An Essay on European Demographic History.* Cambridge: Cambridge University Press.

Livi-Bacci. M. (200l, 3rd English edition) *A Concise History of World Population,* Oxford: Blackwells.

Loudon, I. 1981, "Leg Ulcers in the Eighteenth and Early Nineteenth Centuries" *Journal of the Royal College of General Practitioners* 31: 263-73

Machenbach J. et.al., and the EU Working Group on Socio-economic Inequalites in Health. 1997. "Socio-economic Inequalities in Morbidity and Mortality in Western Europe", *The Lancet,* 349: l,655- l,659

Maclean, I., 2002. *Logic, Signs and Nature in the Renaissance. The Case of Learned Medicine.* Cambridge: Cambridge University Press.

McDonald, T. (ed.) 1996. "Introduction," in *The Historic Turn in the Human Sciences.* Ann Arbor: University of Michigan. 2-12

McKeown, T. 1971. "Medical Issues in Historical demography" (1971) in *Modern Methods in the History of Medicine*, edited by E. Clarke. London: Athlone Press. 54-74.

McKeown, T 1976. *The Modern Rise of Population.* New York: Academic Press..

Mueller, U. 2004. "Does Late Reproduction Extend the Life span? Findings From European royalty" Population and Development Review 30:

Meslé, F. and J. Vallin. 2000. "Transition sanitaire: tendances et perspectives " *Médecine/ sciences*. 16: ll61-7l.

Michaels. L. 2001. The Eighteenth-Century Origins of Angina Pectoris: Predisposing Causes, Recognition and Aftermath. *Medical History.* Supplement No, 21. London, The Welcome Trust.

Mikkeli, H. 1999. *Hygiene in The Early Modern Medical Tradition.* Academia Scientiarum Fennica: Finland.

Mitch, D. 2005. Retrospect and Prospect. In H. Graf, L. Moch and P. McMichael (eds.) *Looking Backward and Looking Forward. Perspectives on Social Science History.* Madison: University of Wisconsin Press.

Mokyr. Joel. 2002. *The Gifts of Athena. Historical Origins of the Knowledge Economy.* Princeton and Oxford: Princeton University Press.

Mosk, C. and S. Johansson, 1986. Income and Mortality. *Population and Development Review* 12: 414-40.

Mosucci, O. 1990. *The Science of Woman: Gynaecology and Gender in England, 1800-1929.* Cambridge University Press.

Nutton, V. (ed.) 1990. *Medicine at the Courts of Europe 1500-1837*. London: Routledge.

Nutton, V. and C. Nutton. 2003. "The Archer of Meudon: A Curious Absence of Continuity in the History of Medicine" *Journal of the History of Medicine and Allied Science* 2003 . 58 #4: 401-427

Omran, A. 1971. The Epidemiologic Transition: A Theory of the Epidemiology of Population Change. *Millbank Memorial Fund Quarterly* 49: 509-38.

Peller, S. 1943. "Studies on Mortality Since the Renaissance." *Bulletin of the History of Medicine.* XIII (13) 427-461

Peller, S. 1965, "Births and Deaths Among Europe's Ruling Families Since 1500." In, *Population and History*, edited by D. Glass and D. Eversley. London: Edward Arnold: 87-100.

Pelling, M. 1997. " Thoroughly Resented? Older Women and the Medical Role in Early Modern London" In, *Women, Science and Medicine 1500-1700*, edited by L. Hunter & S. Hutton. Sutton Publishing Limited, Gloucestershire, UK GL5 2BU.

Perrenoud, A. 1985. "L'Inégalité Social Devant La Mort a Genève au XVIIe-XIXe siècles" *Population* 30 (Numero Special) 221-43

Perrenoud, A. 1997. "Child Mortality in Francophone Europe" In, *Infant and Child Mortality in the Past.* Edited by A. Bideau, D. Desjardin, H. Brignole, Cambridge: Cambridge University Press: 22-37.

Porter, R. 1998. *The Greatest Benefit to Mankind: A Medical History of Humanity from Antiquity to the Present.* London: HarperCollins.

Porter, R. and G. Rousseau. 1998. *Gout the Patrician Malady.* New Haven: Yale University Press.

Preston, S., Keyfitz, N., and Schoen, R. 1972. *Causes of Death. Life Tables for National Populations.* New York: Seminar Press.

Preston. S. M Haines. 1991. *Fatal Years: Child Mortality in Late Nineteenth Century America.* Princeton: Princeton University Press.

Pritchett, L. and L. Summers. 1996, "Wealthier is Healthier" *Journal of Human Resources,* XXXI (4):841-868.

Razzell, P. (2nd edition, 2003) *The Conquest of Smallpox* . Caliban Books, No location.

Razzell, P. 1999 . "Demography, Economics and the Changing Social Structure of England During the Industrial Revolution." Infant Mortality Newsletter l. (April) *Open Studies in Family and Community History.* The Open University: l-14

Riley, J. 2001, *Rising Life Expectancy. A Global History*. Cambridge: Cambridge University Press. See Chapter 4, "Wealth and Economic Development" 122-44.

Riley, J. 2005a "Estimates of Regional and Global Life Expectancy, 1800-2001" *Population and Development Review* 31: 537-544.

Riley, J. 2005b. *Poverty and Life Expectancy. The Jamaican Paradox.* Cambridge, Cambridge University Press.

Riley N. and McCarthy, J. 2003. Demography in the Age of the Postmodern. Cambridge. Cambridge University Press. p. 39

Rosenthal, P. 2003. "The Novelty of an Old Genre. Louis Henry and the Founding of Historical Demography. *Population* (English Edition). 58 (3) 97-l30.

Ruggles, S. (l999) "The limitations of English family reconstitution: English population history from family reconstitution, 1580-1837" *Continuity and Change* 14: 105-130.

Rusnock, A. 2002. *Vital Accounts: Quantifying Health and Population In Eighteenth Century England and France.* Cambridge: Cambridge University Press.

Scheidel, W. 1999. "Emperors, Aristocrats and the Grim Reaper: Towards a Demographic Profile of the Roman Elite" *Classical Quarterly,* 49 (2): 254-81.

Scheidel. W. 2001. *Death on the Nile. Disease and the Demography of Roman Egypt.* BRILL: Leiden,

Schiebinger, L. (1987) "Skeletons in the Closet: The first Illustrations of the Female Skeleton in Eighteenth Century Anatomy." In, *The Making of the Moder n Body* (ed.) C Gallagher and T. Laqueur. Berkeley: University of California Press. 42-82.

Schmidt J. 1959. *Medical Discoveries. Who and Where.* Springfield Illinois: Charles C. Thomas Publishers,

Sebastian, A. (Editor) 2000. *Dates in Medicine. A chronological record of medical progress over three millennia.* New York: The Parthenon Publishing Group.

Schofield, R. 1986. “Did the Mothers Really Die? Three Centuries of Maternal Mortality in ‘the world We have Lost’” In L. Bonfield, R. Smith, K Wrightson (eds.) *The World We have Gained: Histories of Population and Social Structure* (Oxford: oxford University Press. 231-60

Scott, S, C. Duncan, 2002. *Demography and Nutrition. Evidence from History and Contemporary Populations.* Oxford: Blackwell Science.

Siraisi, N. (1992) “The Faculty of Medicine” (Chapter 11). In *A History of the University in Europe* (2vols) *Universities in the Middle Ages* (Vol l) Edited by H. de Ridder-Symoens Cambridge: Cambridge University Press: 368-387.

Smith, G. 1985. “Prescribing the rules of health: self-help and advice in the late eighteenth century’. In R. Porter, editor, *Patients and practioners: lay perceptions of medicine in pre-industrial society*. Cambridge: Cambridge University Press: 248-82. See page 282. [1]University Press: 248-82. See page 282.

Soares, R. 2007. On the Determinants of Mortality Reductions in the Developing World. *Population* and *Development Review* 33(2) 247-287.

Steinmetz, G. ed. 2005. *The Politics of Method in the Human Sciences: Positivism and its Epistemological Others*. Durham: Duke University Press.

Szreter, S. 1988. The Importance of social intervention in Britain’s mortality decline, c. 1850-1914:a re-interpretation of the role of public heath. *Social history of Medicine* 2:2-39.

Szreter, S. Sholkamy, H. and A. Dharmalingam, (eds.) 2004 *Categories and Contexts. Anthropological and Historical Studies in Critical Demography*. Oxford: Oxford University Press.

Turrell, G. and C. Mathers, 2000. “Socioeconomic inequalities in all-cause and specific cause mortality in Australia 1985-87 and 1995 -97.” *International Journal of Epidemiology* 29:231-39.

Vallin, J. , F. Mesle, T., Valkonen. 200l Trends in Mortality and Differential Mortality. *Population Studies* No. 36 Strasbourg, Council of Europe.

Van den Bosch, J, van Poppel, F.. Looman. C. 2000. Determinants of infant and early childhood mortality, levels and their decline in The Netherlands in the late nineteenth century” *International Journal of Epidemiology*, 29: 1031-1040

WHO. 2000. *World Mortality in 2000. Life Tables for 191 Countries*. United Nations. Geneva

Weir, D. 1995. “Family Income, Mortality and Fertility on the Eve of the Demographic Transition: A Case Study of Rosny-Sous-Bois”, *Journal of Economic History*, 55:2-25.

Weir, A. 1996 (rev. ed.) *Britain’s Royal Families. The Complete Genealogy*. London: Pimlico.

Wenzler, C. 2001. *Généalogie des rois de France et les épouses royal.* Rennes: Edition Ouest-France.

Wilson, A. 1997. ”A Memorial of Eleanor Willughby, A Seventeenth Century Midwife” In, *Women, Science and Medicine 1500-1700,* edited by L. Hunter & S. Hutton. Sutton Publishing Limited, Gloucestershire, UK GL5 2BU. 138-177.

Woods, R. 1985 “The effects of Population Redistribution on the Level of Mortality in Eighteenth and Nineteenth Century England and Wales: Revisited and Revised. First version in *Journal of Economic History* 45 1985 645-51

Woods, R. Shelton, N. 2000. *Disease Environments in Victorian England and Wales. Historical Methods* 33:73-81

Wrigley, E. 2004. *Poverty, Progress, and Population.* Cambridge: Cambridge University Press.

Wrigley, E., R. Schofield. 1981. *The Population History of England, 1541-1871 A Reconstruction.* Cambridge, Mass: Harvard University Press.

Wrigley, E. , Davies, R. Oeppen, J., and R. Schofield. 1997. *English Population History from Family Reconstitution 1580-1837.Cambridge:* Cambridge University Press.

Zanetti, Dante, 1972 La Demograhica del Patriziato Milanese nei secoli XVI, XVIII XIX. Instituto de Storia Economica. University de Pavia: Bologna. eo 1600 = 39 1650=43 1700 45, 1750 43 1800 46. P 222

Zimmer, Z. and J. House 2003 “Education, income and functional limitations among American adults: Contrasting onset and progression” *International Journal of Epidemiology* 32(6) 1089-1097.

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