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What length of life did our forebears have?

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Life expectancy at birth now stands at 79 years in France, according to vital registration data. Mortality data for the Ancien Régime can be found in the parish registers in which local priests recorded baptisms, marriages and burials. They are found in a few parishes from the end of the 15th century, and were brought into general use by a royal decree of 1667. The demographers who first began to use them fifty years ago to reconstitute fertility and mortality patterns established that life expectancy at birth was around 25 years in 17th and 18th century France. This measure of mean age at death is often misinterpreted: 25 is not the age at which most people died. At least one in four children did not survive to their first birthday. Mortality declined quite sharply thereafter, but half of all children still died at the significantly sub-adult ages of between 1 and 11. Those fortunate enough to survive to the age of 20 still had a remaining life expectancy of approximately 35 years, i.e., longer than at birth, dying at around 55 years of age on average (figure 1). One in two adults lived to nearly sixty, and a significant percentage past that. Although few in number, older adults did exist, and fulfilled an important social role.

For periods pre-dating this, evidence of ages at death comes from cemeteries. Human bodies develop as they age, and skeletal examination can provide indications of age at death. The best age indicators are bones where development is most evident: age-related synostosis of the sutures of the skull (figure 2), the degree of trabecular involution in the femur and humerus, pubic symphyseal aging, and changes in the fine structure of bone. The condition of the teeth, which wear down with age, is further evidence. The age at death of an individual skeleton is estimated by comparing it with some recent skeletons of known sex and age at death, which form the reference sample. The age of each skeleton in a cemetery once estimated gives the age at death distribution in the population and its mortality profile. The implicit assumption—which may not be true—is that the skeleton population accurately represents the local population.

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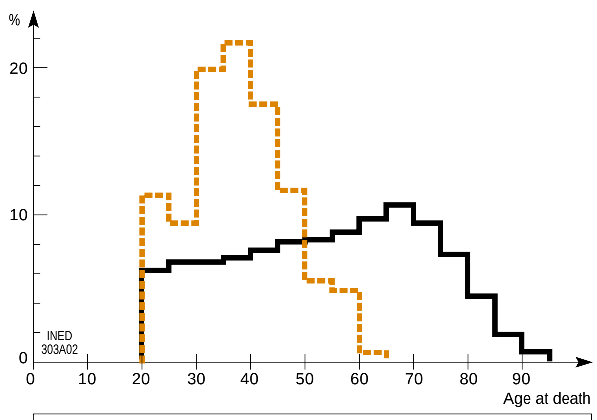
Initial adult mortality studies suggested decimation

This method was first applied in the aftermath of World War One. It yielded surprising but consistent results,

Figure 1 – Adult death distribution by five-year age groups



France, 1740-49, data from parish registers.

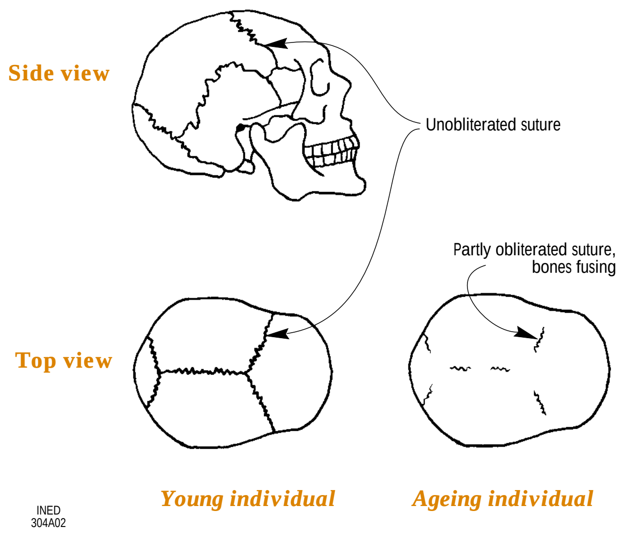
Hungary, 11th century, Fiad-Kerpuszta cemetery, example of a classic study (1954) probably erroneous.

CONTENTS

Editorial – What length of life did our forebears have?

• *Initial adult mortality studies suggested decimation - p. 1* • *Flawed early analyses - p. 2* • *Women's ages too low, infants discarded - p. 3* • *Pre-17th century demographic regime - p. 3*

Figure 2 – Sutures of the skull



confirmed over a series of time- and place-independent periods: from prehistoric times to the 15th century, life expectancy at 20 years of age was apparently about 20 years, varying from 15 to 25 years according to the study. Ostensibly, death came very early; the probability of surviving to over fifty was very low, and there were no older adults. In a curious contrast, infants seemed to have been spared, although to varying degrees according to the cemetery; child mortality often rose around the age of 2 or 3, however. Finally, adult female mortality was much higher than adult male mortality. The decimation of the young female population was attributed to death in childbirth, mortality from the age of 2 to sudden discontinuance of breast-feeding, the lack of older adults to a harsh life. Over time, these results permeated the collective consciousness, and it became common wisdom that our forebears were short-lived.

But this explanation did not hang together, to put it mildly. First, if young women were dying in such droves, how had humankind managed to survive? Then, pre-15th century mortality contrasted sharply with that of the 17th and 18th centuries, which is mirrored, however, in Man's closest animal relatives. Very high infant mortality in chimpanzees and macaques, for example, is followed by fairly high young adult survival. Like humans two or three centuries ago, our primate cousins have a higher life expectancy at early adulthood than at birth. Is that to say that the demographic characteristics of humankind had already diverged from those of pre-human primates in palaeolithic times, endured up to the 16th century, but then in the following century, in a wholly unchronicled demographic revolution, abruptly reverted to the demographic parameters of its distant cousins? And all that just as parish registers were replacing cemeteries as a source of information? The scenario was too unlikely. There had to be something wrong.

Flawed early analyses

In fact, there were several things wrong. Some were statistical, others due to a misunderstanding of ageing, or how bones are preserved in the ground [1].

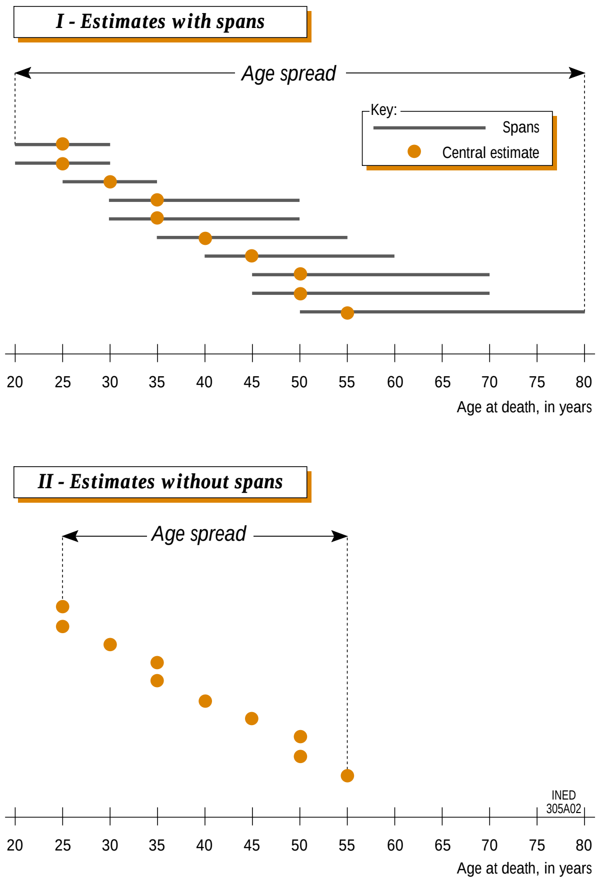
Firstly, bones are poor evidence of age, especially in adults, and individual ages can only be estimated within a span—e.g., "10 years either side" of 40, which means that in two out of three cases, the real age at death is in the span 30 to 50 years. Or rather, somewhere between 34 and 56, given that uncertainty increases with age, and the age spans are not symmetrical.

To compile an estimated life table based on cemetery data not using age spans would be to implicitly assume that errors are self-adjusting, i.e., the higher ages at death of some individuals are offset by others' lower ages. But that is not the case. It is a hypothesis which may be borne out for mean age subjects, but not so for others: there is an unequal number of converse errors (figure 3). Returning to the example cited, without an age span, a subject with an estimated age of 34-56, and a real age of 56, will have an imputed age of 40. If, perchance (one time in six), the subject is over 56, the imputed age will still be 40. So, the tendency is to under-represent the higher end of the range. Whence the lack of older adults.

Another source of error is that age at death distribution in the reference sample may skew the estimate of ages in the study population. To take a deliberately extreme example, suppose the reference sample for estimating is a group from an old people's home. If the group is sufficiently large, it will certainly contain a small number of bones which, because of unequal ageing processes, will still have a young appearance albeit actually old. Suppose the lowest age in our sample to be 65; no skeleton compared with this sample will ever be attributed an age under 65. Were we then to determine the ages at death in a cemetery of predominantly young people (say a military cemetery, for the sake of argument), each soldier would be given an inferred age of at least 65! The result would be equally bizarre if the military cemetery were used as the base frame for the old people's home population. It all comes down to population size: if it is big enough, we shall doubtless find a young soldier with age indicators advanced enough to resemble those of an old person; this young man's age will then be ascribed to the individuals from the old people's home. This is a deliberately extreme example to demonstrate the nature of the bias.

The age at death distribution assigned to the graves of a particular cemetery is an uneasy cross, therefore,

Figure 3 – Eliminating the elderly population by removing the estimation spans



Charts I and II show two ways of presenting the ages at death of 10 skeletons in a cemetery, with and without estimation spans. Eliminating the spans and retaining only the central estimate for each skeleton eliminates the oldest and youngest ages and concentrates the distribution around the central values. The ostensible elimination of the older population is due to "attraction of the mean".

between that of the reference sample and the actual distribution in the reference cemetery. This bias would be eliminated only if, by a remarkable coincidence, the age distribution were to be identical in both samples. In short, a bias-free estimate of skeletal age is only possible if the age structure of its population of origin is already known. But that in turn means achieving a bias-free age at death estimate of its constituent skeletons. How do we break out of this vicious circle?

Women's ages too low, infants discarded

It has long been thought that bone ageing rates are the same for both sexes. But it is not the case for that most commonly-used age indicator, the sutures of the skull. At age 20, women's resemble men's, but their rate of development slows down thereafter to catch up again only in old age: on average, therefore, the cranial sutures of a forty year-old female skeleton resemble those of a male ten years her junior. Gauging by a male calibration standard, then, will create the inference that she died earlier than she actually did. This was long the practice, since the reference samples, which were often supplied by hospitals, and consisted of unclaimed bodies, were predominantly male (1). Only when a sufficiently large sample—849 Portuguese crania of known age and sex—became available was this source of error brought to light [2].

When studying an ancient burial ground, imputing to female skeletons the same rate of ageing as males under-estimated their ages and over-estimated young female mortality. Death in childbirth was certainly high, but less than had been thought.

Another source of error in cemetery analyses is the assumption that rates of ageing had remained substantially uniform since prehistoric times. But we know that growth now occurs earlier than before. Age at menarche has fallen by three years in two centuries in prosperous countries, for example [3]. The long bones no longer fuse at around the age of 25 as they did at the start of the 20th century, but around the age of 20. The sutures of the skull also seem to close earlier nowadays. Consequently, we would assume that ancient skeletons were younger at the time of death than they actually were.

Most cemeteries contain few if any bones of very young children. As those which are found tend to be in good condition, the possibility that they had been badly preserved was not considered. And yet that held the clue. Under 2 years of age, bones lack the chemical composition and texture they will later acquire, and so are less well-preserved. Consequently, many very young skeletons disintegrate before they have had time to fossilize. After that crucial age, they are well preserved [4]. This explains the mortality leap observed after 2 years of age. Far from being caused by weaning, these deaths reflect a mortality which escaped notice before this age.

Remarkably, however, the life expectancies at birth calculated from such biased methods were wholly credible, because the errors of underestimated infant mortality and over-estimated adult mortality were self-cancelling.

Pre-17th century demographic regime

In light of these biases, better than trying to age skeletal material is to use a method to directly elicit the mean age at death of adults [5]. Applied to a Neolithic

(1) For sociological reasons, the bodies of women who die in hospital are more often claimed by their families than those of men.

collective tomb of around 2000 BC (discovered at Loisy-en-Brie, in the Marne department), it yielded a life expectancy at 20 of about 30 to 35 years, i.e., a value close to that for the population of the same area in the 18th century. Caution is nevertheless in order. Discounting children, the tomb had a population of only a hundred individuals. And allowance may need to be made for a selection effect: not everyone may have been entitled to burial in the tomb. Did these burials take place in a prosperous period? during a famine? an epidemic? There are many unknown quantities. One thing which can be said, however, is that the figures obtained would have gone unremarked in a 17th or 18th century parish.

Current or recent populations untouched by modern lifestyles yield a similar pattern. Such populations keep no records, but some have been the subject of statistical studies since coming into contact with Europeans. Many of these statistics are unclear due to the impact of imported diseases like smallpox and influenza, but some have enabled a serious demographic approach: the Inuits of Eastern Greenland, the Kalahari bushmen, the Fula of West Africa, Chinese aristocrats of the Ming Dynasty. Although not entirely lacking in medical knowledge, these populations had only rudimentary hygiene, and knew nothing of vaccination. Overall, their mortality profiles are very close to what historical demography has been able to reconstruct for the 17th and 18th centuries.

While we cannot know age at death distribution for certain, the study of skeletal material has nevertheless shed light on demographic crises. As we saw, a distribution of probabilities of death by age group is biased by the reference sample. But if we use a conventional reference sample with the same number in every age group, the between-cemetery or between-period variations observed may nevertheless be likely to reflect an accurate variation in age at death.

This made it possible to bring to light a major mortality catastrophe in Switzerland, Northern France and Normandy in the second half of the 6th century AD. Although undocumented by historians, the discovery gives insights into certain writings of the time. The same method can be used to compare different burial places within a cemetery, or elicit sociological differences in the same way.

To conclude, it can be safely said that historically, mortality was high only among older adults (who did exist) and very young children, but broadly not so among the majority of adults save when the odd ravages like famine, war or epidemics broke out as under the Ancien Régime, when the classic life tables are found. To be sure, there would have been time-related variations, although it cannot be said in which direction. Over the long term, for example, technological progress may have pulled one way, while increased demographic pressure pulled the other. We can only generalize in the broadest terms. But contrary to the accepted wisdom, the demographic regime of 17th and 18th century France still stands as the most accurate exemplar of its more ancient precursors.

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