

Chapter 2

Epistemology of the Discipline

2.1 Representativeness of the Anthropological Sample

2.1.1 *Biological Archives: Contribution and Limitations*

The palaeodemographic approach to ancient populations as defined above is based on a single source: human bone remains,¹ which are a precious biological archive. It can only be used in those cases where the remains have survived. To adopt an effective demographic approach, the anthropologist attempts to determine the age at death and the sex of skeletons, while the archaeologist uses stratigraphic and typological observations to provide topo-chronological data for the site.

Palaeodemography depends, in part, on the excavation of burial sites that may be very different in size and nature, studied in the context of research excavations or rescue archaeology. In the best case, the site is exhaustively excavated, but usually the dig is only partial. The issue of representativeness arises in all anthropological or palaeodemographic studies. It must be clearly stated, with well-defined limits to the validity of the conclusions proposed. As early as 1957, Gyula Acsádi and János Nemeskéri defined the three preconditions they considered necessary for any demographic study based on osteological remains: the cemetery should be exhaustively excavated and an accurate topo-chronology established, the exhumed skeletons should be well conserved, and there should be biological or social links between the individuals. Since that date, there has been relatively little discussion of the issue²

¹ Consequently, the source is only available where funerary practices involve conservation, such as burial. Cremated remains are hard to use and some funerary practices do not preserve the bones (corpses abandoned, exposed, or immersed). In some cases the bones cannot be studied simply because of their state of conservation.

² Many studies compare the results obtained for a single site from cemetery data and historical demography data, with the occasional wide chronological discrepancy (Piontek and Weber 1990; Molleson and Cox 1993), without checking the respective representativeness of the sets of data. Some studies take care to compare results from the two sources for a single place and time, but

(Walker et al. 1988; Wood et al. 1992b; Hoppa 1999), although in the real world of archaeology and palaeoanthropology all three of Acsádi and Nemeskéri's conditions are never met. The reason is that, from the very moment of burial, social factors (selection by age or social status) and biochemical factors (differential preservation of bones) distort the image of the population one may obtain. In the field, excavation of funeral sites is more often partial than exhaustive and the preservation of the skeletons varies in quality (Fig. 2.1).

In the laboratory, the inaccuracy inherent to the methods for estimating sex and age always leaves room for unwelcome uncertainties and margins of error. Between the buried population and the palaeodemographic sample, defined as the entire set of exhumed skeletons whose age and sex have been anthropologically determined, the loss of information is considerable. This loss must be identified and, if possible, quantified (see Antibes, Fig. 2.2 and Sect. 11.2.2).

2.1.2 From the World of the Dead to the World of the Living: The Question of Representativeness

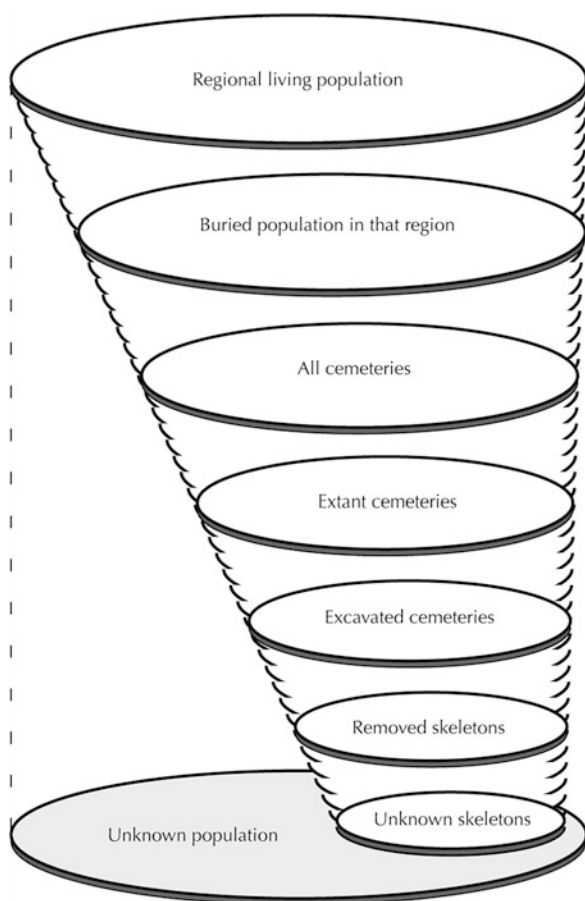
What, therefore, does the exhumed sample represent? Does it show us the world of the living or does it only reflect the world of the dead? The question is now, as it has always been, a critical one.

The first stage is to determine whether the sample is representative of the buried population: do we have all the skeletons that there should be in the burial ground? Was there selection before burial, or were cemetery areas divided by age, sex or social status? Was the excavation partial or exhaustive? If the sample faithfully reflects the sequence of deaths at that time and place, it is possible, with the help of certain hypotheses, to estimate a number of demographic parameters characterising the population that used the site.

The second stage is to determine what population used the cemetery, i.e. the “burying” population. Was it a special group defined by marked social or migratory characteristics, or did it include all the residents in that place? Where there is more than one burial ground for a single community, was the population using the cemetery in question a representative subset of the whole population, or did it have specific characteristics (e.g. socioeconomic or religious)? This concept of “burying” population is an important one: it is what establishes the link between the deceased and the survivors, the world of the dead and the world of the living.

The third stage is to attempt to trace the path back to the living population. This hazardous exercise requires the adoption of preliminary hypotheses about fertility, mortality and migration and the use of demographic models. While our English-speaking colleagues are happy with archaeological and palaeodemographic

with no consideration of the problems of estimating the age at death of individual skeletons (Saunders et al. 1995; Saunders and Herring 1995; Ortega Muñoz 2003).



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Fig. 2.1 Constituting a skeletal sample. *Interpretation:* Obtaining an idea of the population living around the site, assuming that burials were local, calls for knowledge of all the contemporary cemeteries likely to have been used by the residents of the region involved, whose settlement sites are not always archaeologically identified. This would require the cemeteries to be (a) preserved, (b) located by archaeologists, (c) excavated, and the skeletons to be (d) removed and (e) examined. Experience shows that these conditions are hardly ever all met, making it difficult for the anthropologist-palaeodemographer to determine the representativeness of the exhumed sample

modelling, the French-speaking community has remained somewhat reticent towards that approach, preferring to observe and compare skeletal samples.

It is no easy matter to determine the representativeness of an osteological sample. Some anthropologists have focused on the biases due to funerary recruitment and have attempted to estimate the proportion of the buried population that thus escapes the anthropologist's eye. However prudent this approach may be, it

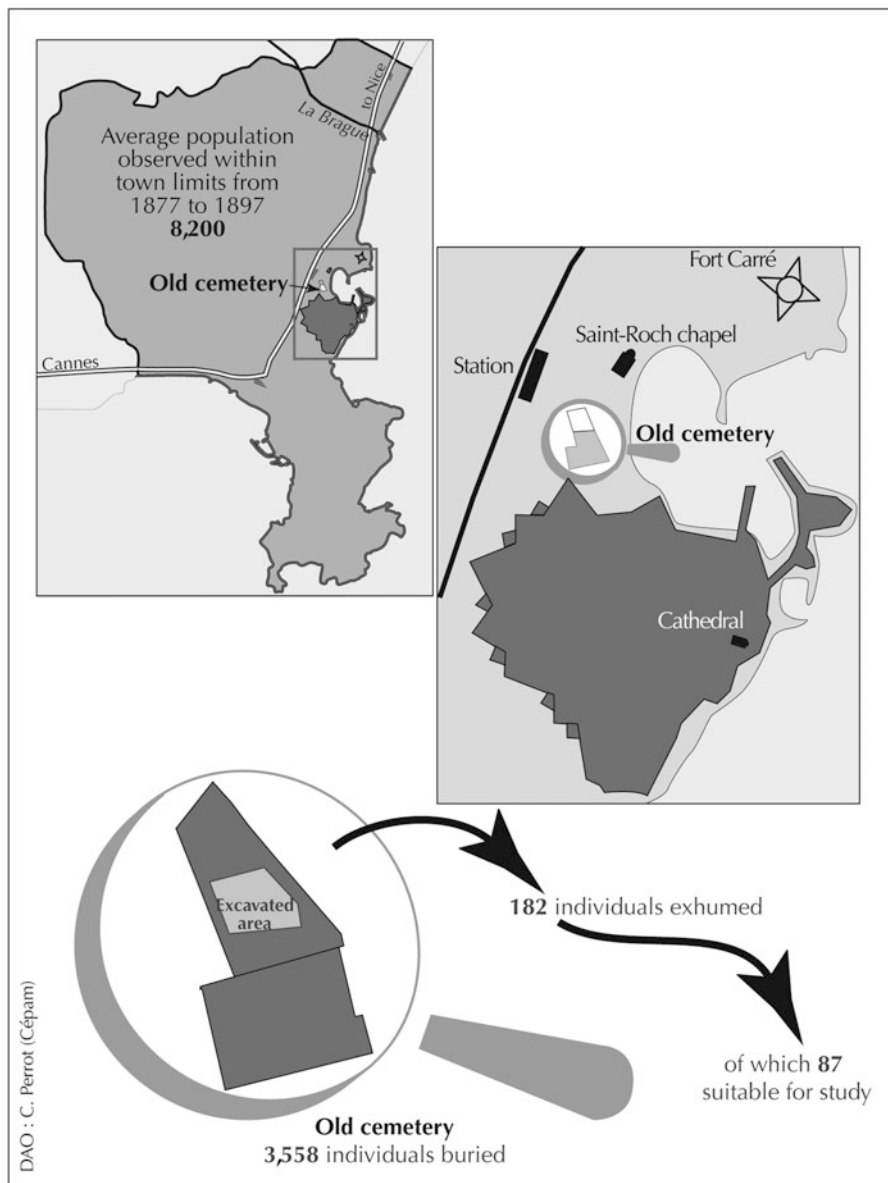


Fig. 2.2 Representativeness of a skeletal sample (Antibes site). *Interpretation:* Each stage in the process leading from the living population to the skeletal sample under study is marked by a loss of quantitative and qualitative information:

- From the “living population” (i.e. all the persons present on the territory under study during the period considered) to the “burying population”, who may only be a fraction, not necessarily representative, of the population occupying the site;
- From the “burying population” (those using the cemetery under study) to the “deceased population”, which is the result of selective mortality (by age, sex, socioeconomic status, or individual pathology) applied to the population exposed to the risk of death;
- From the “deceased population” to the “buried population” in the cemetery under study, which may only be part of the deceased population (particularly where the deceased are buried in their

sometimes leads to discovering biases where in fact there are none. For example, with a cemetery reserved for a religious community, it would be pointless to reconstruct from the buried population the children and adults of the opposite sex who are missing or very few within that community. With a military cemetery, do the exhumed skeletons provide an image of the villagers living nearby or rather of the sub-population using the cemetery, namely the garrison stationed there? Depending on the approach chosen, one may conclude that the palaeodemographic sample is representative or non-representative.

The approach is a difficult one, requiring the researcher to go beyond the usual standard frameworks (parish cemetery, “natural population”) and compare, wherever possible, the “ground archives” with the historical archives in order to seek out the features specific to each burial site and, consequently, its recruitment. For example, there is a high risk that a change in the recruitment of the cemetery population (e.g. a burial ground originally reserved for a small group of socially privileged persons which was opened up to the entire community) may be wrongly interpreted as a change in health conditions.

We cannot, therefore, stress too strongly the precautions that must be taken when attempting to assess the living population from the osteological remains of a few of its members. Even in optimal archaeological conditions it is never certain that the proportion exhumed is significantly representative of all the components of the buried population. For example, a brief calculation shows that hardly 50 % of the expected population has been found in the rural medieval cemetery at Frénouville (Normandy, sixth–seventh centuries AD), even though the burial area has been fully excavated (Buchet 1978; Pilet 1980), because most of the children are missing. The palaeodemographic sample taken from the urban cemetery in Antibes (Alpes-Maritimes,



Fig. 2.2 (continued)

- place of origin, or where there is more than one burial ground, or where funerary practices vary according to the deceased person’s age or social category);
- From the “buried population” to the “exhumed population”, which is a potentially biased sub-sample because the archaeological excavation was not extensive or the skeletons were preserved differentially by site or age (with fewer of the youngest and oldest) or sex (with more men), although the subject is still disputed;
- From the “exhumed population” to the “analysable population” (the palaeodemographic sample) from which the anthropologist attempts to determine sex and estimate age, and which comprises only the well-preserved skeletons (whose proportion depends on the quality of the excavation and storage conditions).

In this case (Antibes from 1877–1897, see the study in Sect. 11.2.2), the observed living population totals around 8,200 individuals, of whom three-quarters lived in the city centre (blue area), and one-eighth in the broad expanse contained within the city limits (grey zone). The remaining eighth is the population counted separately, corresponding to people temporarily residing in the city but domiciled elsewhere.

The burying population is more or less the living population, and a similar hypothesis is made for the overlap between the deceased population and the buried population. As the cemetery was only partially excavated, only a small proportion of the individuals recorded as buried there were collected (5 %), from whom fewer than half made up the palaeodemographic sample.

nineteenth century), although it includes only 2.5 % of the population that was buried there, has turned out to be statistically representative of the age distribution of buried adults (for more detail, see the site studies in Chap. 11). It is consequently not so much the sampling ratio that matters as the sampling method. A random sample is more likely to represent all the components of a population than a sample taken from a burial selection (which is nonetheless representative of the selected population).

2.1.3 Problems with Small Samples

The Antibes case (see Chap. 11) exemplifies another recurring problem in palaeodemography: the small number of skeletons observed. Few sites are able to provide more than a hundred or so analysable skeletons, which then need to be classified by chronological phases of varying duration.

The many studies that seek to circumvent the difficulties of the discipline, and merely compare samples with each other, either chronologically or geographically, inevitably run into this problem, without necessarily realising its full extent. Any conclusions drawn from these comparisons lack a degree of statistical significance. The small number of individuals generally analysed may provide a deceptive picture and random variations are like mirages in the field of palaeodemography.

It is difficult, therefore, to identify a general trend from an insufficient number of skeletons, because it is masked by the dispersion of their individual characteristics. As a result, findings that may appear to reveal major changes in mortality from one site to another, or one period to another, in fact merely reflect random variations affecting the small number of skeletons observed.

The reliability of palaeodemographic findings depends closely, therefore, not only on the thoroughness of the method used but also on the sample size. This is why we believe it is important to specify the statistical limitations of the results obtained by applying validity tests and calculating confidence intervals.

For small samples, non-parametric tests³ are to be preferred, because they do not assume that distributions are normal. They are more sensitive to the median than the mean (ranking). Note, however, that these tests have less statistical power than parametric tests (for equal sample sizes).

2.1.4 The Migration Question

The survival of DNA in archaeological bone remains gives us a direct access to the genomes of past populations and makes it possible, among other things, to

³ We may cite Mann–Whitney and Wilcoxon’s tests, which can be used to compare two independent samples, and Krukskal–Wallis’s test, which determines whether k populations are identical and whether at least one of them tends to be different.

reconstitute migration patterns. This approach is as yet limited owing to problems of contamination, conservation and recovery of DNA from the bones, and also to the cost of the analyses. Pending the information on large series promised by current research on DNA, the only way of identifying migrants in a skeletal sample is to observe each individual's phenotype by macro- and microscopic examination, supplemented by physico-chemical analysis of the bones collected. However, it must always be borne in mind that although the phenotype does reflect the genotype, any resemblances between individuals found in this way do not guarantee relatedness, just as relatedness does not always translate into resemblance.

The phenotypical differences between populations originate from the history of settlement under the combined effect of biological, social and environmental factors.⁴ The weight of each factor is hard to discern: some people migrated, others transmitted ideas and material cultures, and others adopted them. It is this alternation between change and equilibrium, this permanent biological and cultural cross-breeding, that causes populations to be born, die or transform themselves and that underlies their homogeneity or heterogeneity at a point in time t of their existence. By analysing the morphological effects of these changes on skeletons, the anthropologist may hope to reveal migrations, but in order to conclude that a biological phenomenon, such as morphological heterogeneity, corresponds to a historical phenomenon, such as migration, anthropological data cannot be used alone; they must be cross-referenced against all the data available, both archaeological and historical.

This exercise is not risk-free and to base historical conclusions on osteological data is not a straightforward task (witness the misuse of anthropological analysis by certain ideologies). For that reason few anthropologists go there, preferring to assume that their populations are closed and to conclude that the observation of bone remains is pointless for the study of settlement patterns.

2.1.5 Is It Futile to Study the Demography of Archaeological Populations?

The pitfalls encountered by palaeodemographers when they attempt to describe the population to which an archaeological sample belongs have been clearly signposted. Yet the techniques for overcoming these obstacles with a satisfactory margin of confidence remain to be established. The picture of the living population as provided by a set of deceased persons supposed to represent them is distorted by a range of factors that are hard to identify and, therefore, difficult to correct.

Nevertheless, the palaeodemographic sample does, to some extent, reflect the mother-population. For some of that population's demographic features it does

⁴The influence of migration, and the effects due to small samples, are well described in Langaney 1988.

provide some meagre information, albeit obscured by funeral practices, and it translates what the living thought of themselves via their presentation of their dead and their ideas about death. We believe, therefore, that it is possible to cautiously move towards creating population models from archaeological and anthropological indicators.

2.2 Ideas About Age

2.2.1 *Age, a Word with Many Meanings*

Age as a quantitative, continuous, generally reliable fact has been one of the foundations of demography since the first “political arithmeticians” established the link between mortality and age more than three centuries ago.⁵ The use of this variable in exploring and revealing socio-demographic phenomena, with respect to the age of the individuals who experience or initiate them, gives credence to the idea that age is the determinant of most demographic behaviour (Véron 1994). However, a concept as “ordinary” (Pressat 1979) as age, marking the time elapsed from an individual’s birth until the demographic phenomenon analysed, should not conceal the various realities it covers for different speakers in different times and places.

In palaeodemography, age measures the time elapsed between birth and death (discerning events during the buried person’s lifetime remains extremely difficult). It is not calculated from historical civil records or declarations of age (in, say, a funerary inscription), but rather estimated from biological indicators of growth for juveniles and of ageing for adults. It is therefore not a civil or chronological age measuring events occurring between two calendar dates but a biological age expressed variably in each individual within a well-defined developmental pattern. In other words, an individual’s biological age necessarily falls within a range of estimates reflecting the biological diversity of the whole population. Use of biological age leads us to consider the idea of age with a certain “distance”, to look beyond an *exact* age to a *probable* age, ascribing to this variable an unusual degree of relativity.

Neither is the age we work with the exact measurement of time elapsed between birth and death, but rather the reflection of the individual’s place at a given time within their social environment. Hierarchy and the social segmentation of ages vary from one time and place to another. In truth, analysing demographic phenomena on the basis of such a relative variable involves a number of paradigm changes, which we venture to outline below.

⁵ This section is based on a paper given to the AIDELF conference in Dakar, 2002 (Séguy and Buchet 2006b).

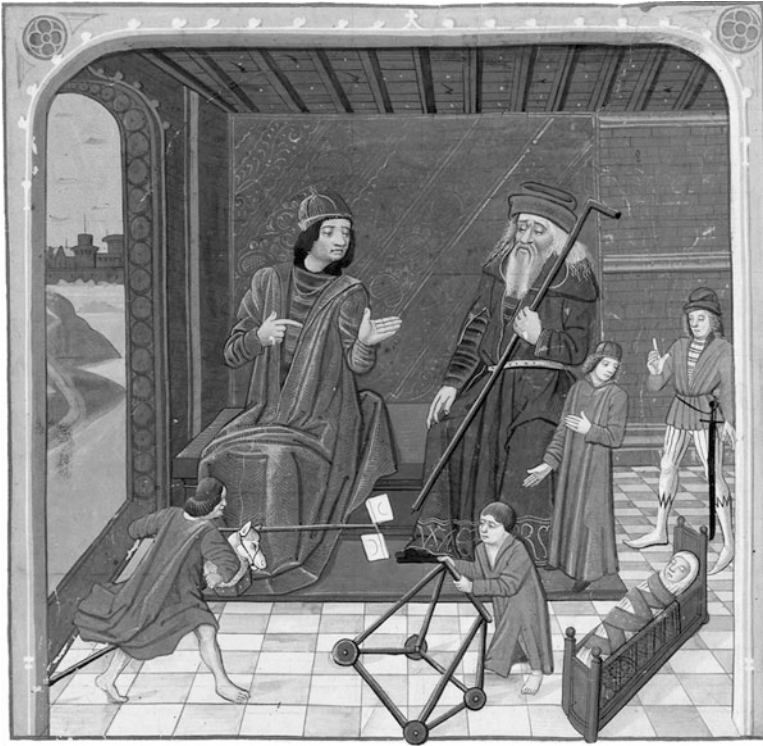


Fig. 2.3 The ages of man. Illumination from Jean Corbichon's translation (fourteenth century) of *De proprietatibus rerum*, Bartholomeus Anglicus (thirteenth century). © BnF

2.2.2 *Civil Age, Biological Age and Social Age: An individual's Place in Society*

Age is not only the measure of the number of years lived but also, and perhaps above all in the periods of interest to us, a state. For both adults and children, every age in life is characterised, in social, political, economic and legal terms, by the powers it confers or denies, which distinguish it from other ages. The breakdown of life into various stages is a universal phenomenon, but the stages are not the same from one culture to another. They correspond to individuals' perceptions of the continuities and discontinuities in their own lives (Haraven 2000).

The social structure of medieval France, for example, used a division of ages inherited from classical tradition and identified by Gregory of Tours, who distinguished seven⁶ ages (Fig. 2.3). Three ages in childhood: *infantia* up to 7 years,

⁶The number 7 had a great symbolic value in Antiquity and throughout the Middle Ages.

pueritia from 7 to 14, and *adolescentia* from 14 to 21; and four ages in adulthood: *pueritia adolescens* up to 25 or 30 years, *juventus* up to 40 or 45, *senectus* up to 60 or so, and *senium* beyond 60 (Lett 1997).

This division has the merit of roughly corresponding to physiological observations: appearance of first permanent teeth, puberty, menopause, and old-age dependency. Educators, doctors and lawyers agreed that the stages of biological development marked the child's progress within society: from birth to the first deciduous teeth at about 2 or 3 years, which corresponded to the age of weaning⁷; from the age of reason, at about 7 or 8 years, and the first permanent teeth, to puberty, at about 14 or 15 years,⁸ which marked the end of childhood and entry into the world of adults. In mediaeval France, the legal age of majority was 14 or 15 years for boys and 12 years for girls (Alduc-Le Bagousse 1994, p. 32). At that point adolescents had rights, such as that of pleading or testifying, and duties. This was also the average age at which boys entered apprenticeship or, in the aristocracy, began to bear arms; whereas for women, the age of majority and the age of marriage often coincided.⁹

In the eyes of their contemporaries, adolescents were adults; in the eyes of the anthropologist, they were still immature. And what of the demographer? By including them as "children", are we not overlooking the "adult" risks to which they were exposed, such as pregnancy and accidents of warfare?

Other ages raise problems for the palaeodemographer, particularly the youngest, since infants remained outside society until they were enrolled into the Christian community by the sacrament of baptism¹⁰ (Lett 1995). The many newborns who died before being christened were often banished to the margins, literally, of the Christian cemetery (Treffort 1997; Séguy 1997; Séguy and Signoli 2008; Tzortzis and Séguy 2008; Séguy 2010).

2.2.3 Towards Socially Significant Age Groups

Clearly therefore, social age categories, like biological ages, do not strictly align with civil age groups. While for demographers age is regularly divided in a linear but rather artificial fashion, for anthropologists (in the broadest sense), historians and palaeodemographers, age corresponds to uneven segmentations (Fig. 2.4). Although it can be convenient to use predefined age groups, this may also mask serious breaks and discontinuities.

⁷ Late weaning is attested by both written sources and anthropological analyses (Gallien 1992; Herrscher 2003).

⁸ Age at which it is agreed that the girls of that period had their first periods (menarche) (Post 1973; Lett 1997).

⁹ Many mediaeval literary sources illustrate the early age of marriage for girls throughout the Middle Ages, at least in aristocratic society.

¹⁰ Infant baptism, just after birth, was far from general practice before the twelfth century, even in aristocratic families, who were the most Christianised (Alexandre-Bidon and Lett 1997).

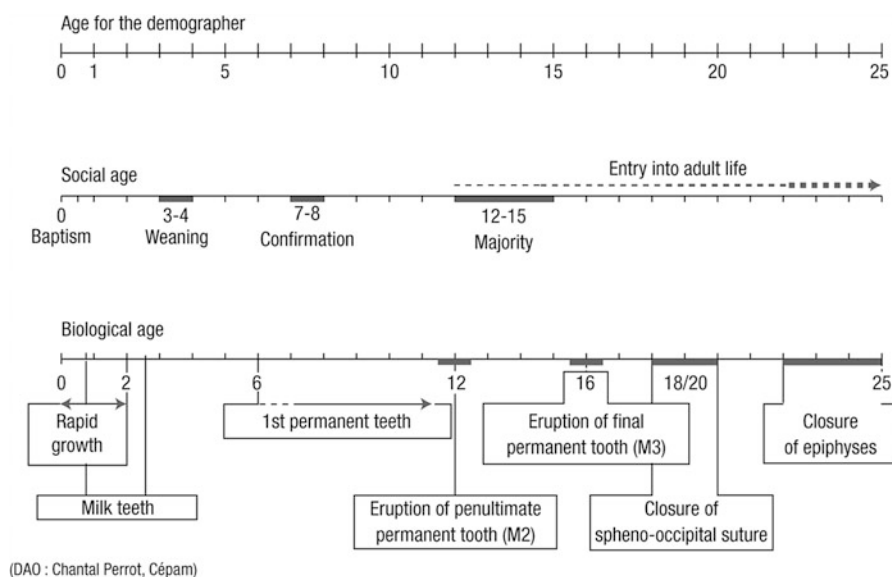


Fig. 2.4 Biological stages and social time

Demographic analysis must be able to detect any inflection points in the measurement of risk; and mortality, fertility and indeed migration,¹¹ must be measured with respect to the individuals concerned. Just as the scale chosen to observe demographic phenomena – short, medium or long term – determines the vision we may have of them (Véron 1994, p. 378), so age grouping by socio-biological criteria may well provide a new viewpoint for certain demographic phenomena, particularly for children (Séguy and Buchet 2006; Buchet and Séguy 2008).

2.3 Considerations Concerning Reference Populations

2.3.1 *The Hypothesis of Biological Uniformity*

All currently available methods for estimating age were developed on sets of *recent* skeletons whose sex and age at death are known; these sets are called “reference populations”. The morphological criteria recognised to be discriminating

¹¹ Far from being sedentary, children in the Middle Ages often left their homes, or even their towns or villages, for events as varied as family recomposition after a separation or death of one of their parents; oblation (gift of a child to a monastery); marriage; starting work or apprenticeship; entering domestic service; fosterage (the aristocratic practice of entrusting an adolescent’s education to another lord). The practice of entrusting infants to wet-nurses appears to have been only marginal at that time; this was not true of child slavery, which involved much larger-scale migration.

parameters in the reference population are then used on ancient series. These methods assume, therefore, that the biological parameters used are constant, or vary little, over time.

This is the hypothesis of biological uniformity (Howell 1976), invoking the non-variability of biological phenomena over time, that underpins all palaeodemographic research. It posits that (a) the biological processes relating to human mortality and fertility in the past are similar to those observed at the present day by demographer-anthropologists and that (b) biological development takes place within the same timeframes for all populations, irrespective of time and place.

These last two postulates have been the subject of lively discussion within the palaeodemographic community for the last 15 years or so.

Although we cannot accurately measure them or be sure of their linearity, growth processes do appear to vary over time and space. Over a short time period (a few generations), changes have been measured in a number of biological processes, such as in the order of eruption of teeth, in the mean age of puberty (Biraben 1982; De La Rochebrochard 2000) and in growth processes related to recent improvements in living conditions (Hoppa 2000b; Piontek et al. 2001). The use of standard correlation tables constructed from contemporary observations should therefore, in theory, be restricted to populations whose dietary, health and economic conditions are close to those used as models. In practice, until such day as more ancient reference materials become available, ages at death of all children and adults buried since the first Upper Palaeolithic sites are still determined on the basis of contemporary reference populations. For these reasons, in addition to the individual variations reflected in a mean age, there is a non-measurable margin of uncertainty between actual age at death and estimated age.

Palaeodemographers are aware of the fragility of the biological uniformity hypothesis underpinning their work and have pondered the possible consequences of a drift of biological markers over the centuries. If the growth or ageing processes do not occur at the same speed in the archaeological population as in the reference population, major discrepancies between estimated age and actual age may occur. However, although the possibility of a centuries-long drift of biological age indicators cannot be dismissed,¹² anthropologists have chosen to neglect it, for lack of any means to measure it,¹³ while hoping that any discrepancies are not too great.

¹² For example, with respect to the drift in the closure of cranial sutures: (Masset 1982; Bocquet-Appel and Masset 1995; Simon 1983, 1987; Molleson and Cox 1993). More recently, Hoppa (2000b) has revealed morphological changes in the pubic symphysis between two chronologically distinct samples.

¹³ According to Masset and Castro e Almeida, "This is as yet only a statistical link, which we are largely unable to interpret. . . To settle this point, we lack too many data that lie inaccessible in the cemeteries", (1990, p. 130).

2.3.2 Towards a Pre-industrial Biological Standard?

One solution is to come as close as possible to the standards of pre-industrial populations, albeit not ancient or medieval, who are largely non-urbanised, have little or no access to modern medicine and have barely, if at all, begun their demographic transition. This is how Bocquet-Appel (1977b) and Masset (1982) proceeded, by choosing collections of skulls from the late nineteenth century. This is also the solution adopted in this handbook.

However, although well-documented nineteenth-century bone remains are available, establishing an acceptable reference population remains a delicate task. Each usable series has its own characteristics and it is often hard to interpret the differences observed between series. When the reference collection intended for studying cranial sutures was being established (see Sect. 4.1), major differences in the age distribution by cranial closure were found between the Portuguese collections used by Claude Masset¹⁴ and the Simon collection¹⁵ in Geneva. Is this the effect of geographical distance (ethnic features), local health conditions (more deaths from tuberculosis and epidemics in Lisbon), difficulties in interpreting the closures (now impossible to verify since the Portuguese collection was destroyed by fire in 1978) or small sample size?¹⁶

For the purposes of estimating children's age at death, establishing a reference collection is even more problematic. Since there is no properly accessible osteological collection, the solution is to establish a reference collection on the basis of dental indicators. This task too is a delicate one because the only data available for the nineteenth century concern tooth emergence; for example, the major series published by Eduard Mühlreiter in 1920 gives the mean ages for tooth eruption among children in Vienna between 1870 and 1890. However, a comparative study of two populations, one from the Roman period and the other from the nineteenth century, concludes that there is no significant drift in the tooth mineralisation process (Saunders et al. 2000), so we can accept the hypothesis that observations of contemporary teeth may serve to construct a reference population. Care must be taken, however, to measure the degree of mineralisation and not emergence, which cannot be observed on dry bone.

2.3.3 Influence of the Sex and Age Structure of the Reference Population

Without an appropriate method of correction, the profile of the sex and age structure of the reference population determines that of the population under archaeological study, as Masset has shown. There are basically two causes for this, biological and

¹⁴ See Chap. 4, Box 4.1, concerning the three Portuguese reference collections.

¹⁵ Concerning the creation of this collection, Gemmerich Pfister 1999.

¹⁶ Differences in age distributions by cranial closure may be observed between populations. They do not contradict the theory of biological uniformity, which holds that age distributions of stages of closure remain invariable.

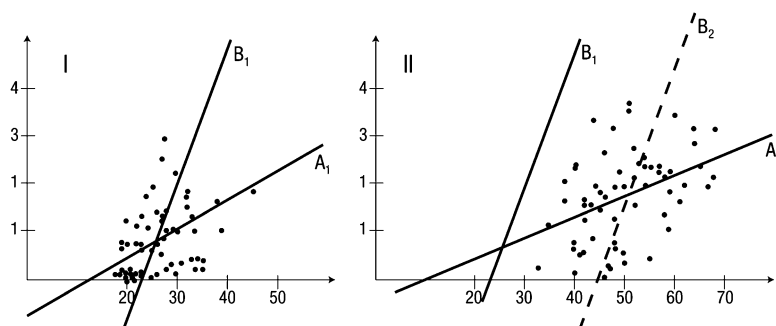


Fig. 2.5 Influence of structure of reference population on structure of study population. *Interpretation:* The regression lines A_1 and A_2 of sutures by age vary little between populations I and II (biological uniformity). The regression lines B_1 and B_2 of ages by suture, on the other hand, depend on the distribution by age at death of the selected reference population. Populations I and II have quite different age distributions. If regression B_1 , based on the suture characteristics of population I, was used to estimate the age of the individuals in population II, the results obtained would be quite unrealistic. *Source:* Based on Masset 1982, p. 23

statistical. Whereas the biological indicator of age is a linear function of the subject's age within limits that vary little from one population to another, an individual's civil age is only partly a function of the biological indicator, because of considerable individual variability. In other words, while a given biological age corresponds to a stage of suture closure, that stage of suture closure does not correspond to a precise chronological age.

Furthermore, Fig. 2.5 clearly illustrates the difference in approach between the probability vector method (based on the B regressions) and those proposed by Jean-Pierre Bocquet-Appel and Jean-Noël Bacro (2008) and Henri Caussinus and Daniel Courgeau in the prospective part of this book, Chap. 13, which are based on the A regressions.

Choice of reference population alone may explain alleged differences between two archaeological sites. In Fig. 2.5, depending on whether the individuals included in the comparison collection are mostly young (reference population I) or older (reference population II), the estimated distribution by age at death in the archaeological series will reflect these differences.

Mathematically speaking, the matrix approach used to estimate a “collective” age at death takes no account of the structure of the reference population, since the frequencies are observed by age group.¹⁷ However, in practice (Fig. 2.6), the

¹⁷ This observation holds whatever the mode of calculation: frequencies of biological stages by age group (see Chap. 5) or frequencies of age groups for a given stage (prospective part, Chap. 13).

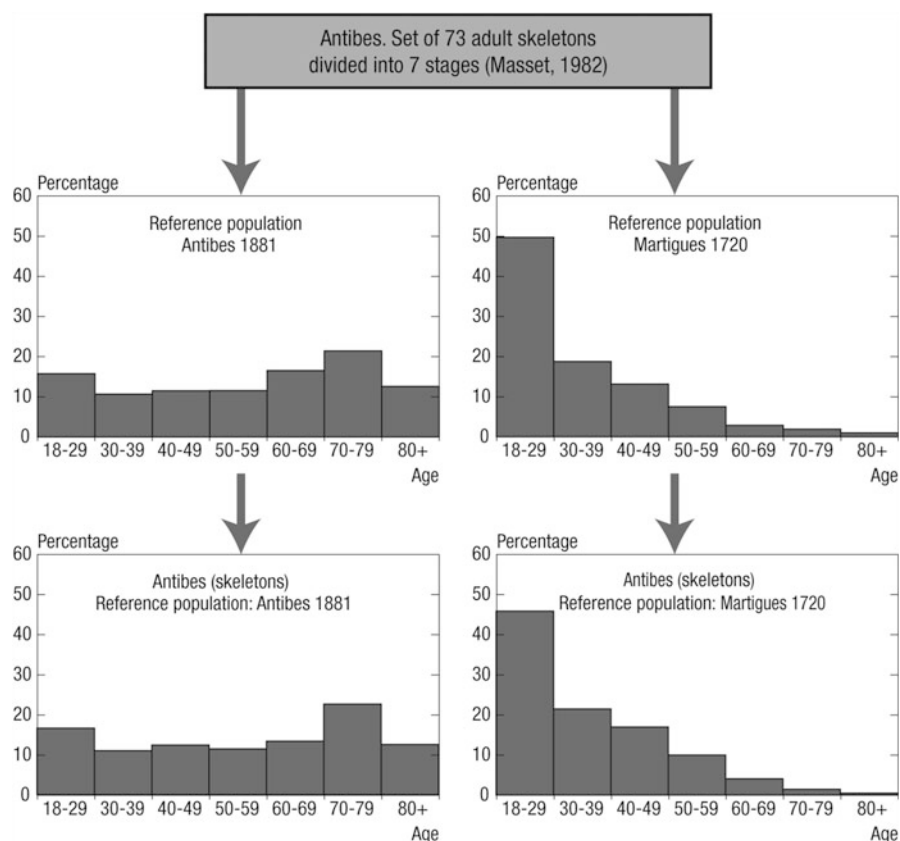


Fig. 2.6 Influence of reference population structure. *Interpretation:* The archaeological population taken from the dig at the old cemetery in Antibes (late nineteenth century) was adjusted to the age structure of deaths in the town of Antibes in 1881 (Buchet and Séguy 1999, 2003) and to that observed during the plague epidemic in the town of Martigues in 1720 (Signoli et al. 2005; Séguy et al. 2006b)

statistical distribution comes up against the dual problem of the small number of individuals in the comparison collections (see the inventory proposed by Usher 2002) and the even smaller number of archaeological skeletons to which these calculations are applied.

Similarly, the sex distribution in the reference population may have an effect when the osteological indicator of ageing evolves differently for men and women (such as the closure of cranial sutures, see below). In fact, palaeodemographers must remain alert to the nature of the reference collections that underpin their results.

2.3.4 *Choice of Reference Population Structure*

One solution for reducing this bias¹⁸ would be to establish the largest possible comparison collection, with each age group having roughly the same number of individuals, and, if possible, a balanced sex ratio. This constraint can, to some extent, be integrated when establishing a comparison sample based on contemporary individuals (see Chap. 4), but cannot be introduced in dealing with older comparison collections, without running the risk of moving away from the biological model of pre-industrial populations. Alternative solutions have been considered.¹⁹

2.3.4.1 *The Idea of a Standardised Population*

In order to control the influence of the reference population and prevent it from being reproduced in the study population, Claude Masset (1982) thought of “standardising” his collection so as to produce a neutral reference population. To that end, he allocated to each age class the same number of individuals, proportional to the number of years included (the first had 12, the last 4, and all the others 10).²⁰ Where there were insufficient subjects in an age class, he randomly created fictional individuals with the same sutural characteristics as those in that age group. In their attempts to estimate the distribution of ages at death in their study populations, this “standardised” comparison collection provided anthropologists with a reference population that was both common to all (enabling inter-site comparisons) and assumed to be bias-free since it had no intrinsic structure of its own (the age distribution is linear, reflecting the underlying histogram, which is flat).

This proposal was adopted and improved by Christian Theureau in 1996 and 1998. Noting that the palaeodemographic results were influenced not only by the age distribution of the reference population but also by the stage distribution of the biological indicators, he established a new reference population with the same numbers in each age class and each stage. For that purpose, he collated the data from two comparison collections, in Hungary (Nemeskéri and Harsányi 1958; Acsádi and Nemeskéri 1970) and Portugal (Bocquet-Appel et al. 1978; Masset 1982). But only the individuals in the Portuguese collection are of known sex and

¹⁸ The influence of the reference collection would not be eliminated, but would be reduced to a flattening of the estimated distribution.

¹⁹ All the proposed solutions are based on the probability vector method, the only one used by French palaeodemographers until recent work by Jean-Pierre Bocquet-Appel (2008b) and Henri Caussinus and Daniel Courgeau in this handbook. Starting from the stage distribution observed in a given age group, the new proposed solution avoids the problems of a possible centuries-long drift and the influence of the structure of the reference population, since it depends only on the assumption of biological uniformity.

²⁰ Some authors have criticised this choice of methodology on the grounds that natural populations never present an equal probability of dying in all age classes (Buikstra and Konigsberg 1985; Konigsberg and Frankenberg 1992; cited by Schmitt 2002).

age. In so doing, the author falls into other statistical traps: first, ages and stages cannot be standardised simultaneously; one has to be chosen over the other (stages, say); and second, he bases his estimates on observed data (age at death for the Portuguese collection) and *estimated data* (individual age by osteological indicators, with no margin of error, for the Hungarian collection).

2.3.4.2 A Pre-industrial Population Structure

Use of a standardised reference population is not satisfactory because a population never has a uniform age structure. The distribution of ages at death is not flat and the proportion of old people is generally much higher than that of the young (except for the special case of military cemeteries). Consequently, the distribution of deaths obtained from a standardised reference population considerably overestimates the proportion of young adults, at the risk of leading to erroneous explanations linked to social conditions or health.

However, it is useful to maintain this unity of method and measurement that is the strength of anthropological research in the French-speaking world, and propose a population structure that is acceptable as a reference population for historical periods. We believe that it should come as close as possible to the characteristics of pre-industrial populations (see Chap. 4).

2.3.5 *Other Insidious Biases in Current Reference Collections*

In addition to the previous two problems (over-contemporaneous assumptions and the influence of age and sex structure), the currently available comparison collections suffer from other failings, no doubt considered to be minor, that nonetheless influence estimates by sex and age of buried populations.

The fact that these collections generally only contain a few tens or hundreds of individuals rules out any representative statistical coverage of the entire spectrum of possible realities. Collections with thousands of individuals may suffer from other biases, every bit as serious, such as attribution of age by biological criteria rather than civil records (unclaimed corpses and violent deaths, for example), serious illnesses unrepresentative of the general health of the population (in the case of anatomical pathology collections).

Most collections are made up of the unclaimed corpses of patients who died in hospital.²¹ If health status and socio-economic category affect the chosen biological age criteria, then this type of recruitment may well impact the estimate of age at death.

²¹ They also include the corpses of people who donated their bodies to science, and those taken from morgues, autopsy rooms and prisons (see Yann Ardagna's 2004).

2.3.6 *Towards an Ideal Comparison Collection*

Even if the ideal comparison collection remains utopian, attempting to define one is a way of identifying the failings and advantages of existing collections.

In absolute terms, an ideal collection would comprise several thousand individuals, with equal proportions of males and females of all ages (including extreme old age), properly registered in civil records. These individuals would be fully preserved (skeleton, skull and *postcranium*) to allow for a multi-criteria approach to age estimation, while maintaining a relative population homogeneity. Not least, to ensure a certain uniformity in growth and ageing processes, the population would be precisely situated in time and space as close as possible to the pre-industrial populations for which it was to act as yardstick.

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