

Fundamentals

1 Introduction

1.1 Reasons for population studies

There are many good reasons for studying population statistics. The most general of these is the advancement of science: finding out what happens, formulating theories as to why it occurs and testing these theories against the course of events. Secondly there is practical value in measuring population growth so as to be able to plan ahead for satisfying man's needs throughout life – food, clothing, shelter and other necessities. Thirdly there is the aspect of the subject that is sometimes called 'political arithmetic' – the name that some of the pioneers of demography used to indicate the nature of their interest in population: demographic data may facilitate the making of arrangements for the ascertainment of people's views on important topical questions, the election of representative governing bodies, the collection of taxes, the planning and conduct of industry and commerce, the provision of social services, the maintenance of health and the preservation of law and order. Such data may also help to give some guide to the probable outcome of such activities. The changing balance of young and old people, for instance, affects government expenditure on matters such as education, child welfare, housing and pensions, and the more the demands of the future can be foreseen, the better the planning can be.

Finally, some governments have developed or are developing policies involving legislation or other action designed to have an influence (or to eliminate certain influences) upon the size, trend or distribution of population; and, even where governments have not gone this far, many people believe that they should do so. The study of the appropriate statistics is clearly important, in these circumstances, either in order to monitor progress and check effectiveness or to attempt to establish a case for or against a policy. Some institutions, such as political parties, the Church and scientific societies have set up associated organizations for the analysis or presentation of population material and the development of arguments therefrom.

1.2 Characteristics

Demography is a term derived from the two Greek words, *δῆμος*, the people, and *γράφειν*, to draw or write. It was first used by Guillard in 1855, and

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nowadays denotes the study by statistical methods of human populations. This involves primarily the measurement of the size and growth or diminution of the numbers of people. The constituents of change in these numbers are births, deaths and migration, and demographers analyse the related functions of fertility, mortality and population transfer.

They take an interest in the influences – social, political and economic – which operate on these functions, in the interplay between them, and in their effect on the population as a whole.

Populations can be studied also for their characteristics at a single point of time, for example age-distribution or genetic composition. Such characteristics do not often change very rapidly. Moreover, there is a particular association between the numbers of people in an area at different times, namely that those aged x at time t are the survivors of those aged $x - s$ at time $t - s$, subject to the forces of mortality and migration. This association can be a close and ordered one and it imparts a special flavour to the subject because it opens up possibilities for mathematical analysis. Population may also be assessed by means of algebraic disciplines in which conclusions are reached by rigorous logical procedures on the basis of specific fundamental assumptions. Such work leads to theoretical statistical models, and these may be either stochastic or deterministic in character – that is, they may or may not allow for chance variations to individual members of the population. Among the topics which are studied in their relationship to population are natural resources, production and consumption, labour supply, housing, savings and investment, ability and education. Many of these studies are not particularly mathematical in character, but can be pursued with the use of electronic computers able to handle large masses of data with many classifications.

Intense public interest is expressed in the prospects for the future development of the population, and most of the studies mentioned above can lead to some sort of forecast for, or projection into, the years to come, although it is well known that estimates made in the past have not so far been accurately borne out in the event. Our knowledge is at present insufficiently complete for success in forecasting.

1.3 Theory and practice

The study of population may be approached in a number of different ways. For instance, it may be made the subject of very general argument or philosophical speculation without recourse to any statistical analysis. This method of approach belongs mainly to the past, before adequate and reliable data were available, but it may still be of some use in limited fields. A more common discipline today is the collection of statistics as a basis for empirical analysis. The results of individual studies of this kind may be of only local application,

but broader generalizations may well be possible upon the basis of a group of such surveys. Besides numerical data, evidence such as newspapers, Acts of Parliament, other public documents, and miscellaneous writings of various kinds may be adduced in demographic research: novels and advertisements have been used as basic material.

In economically well-developed countries today it is customary to register births, deaths and marriages and to hold periodical censuses; the information collected is sufficiently accurate for many demographic purposes. Such information indeed provides most of the raw material of the demographer's work, and some familiarity with the particular characteristics of these data, as well as the statistical returns and reports where they may be found, is essential for their proper use.

1.4 Definitions, and links with other disciplines

It is sometimes argued that certain branches of population analysis should be distinguished from others by a separate title. In this connection the word 'demology' has occasionally been suggested as an indicator of the more learned branches of the subject; but this has not come into general use. Rather more commonly, the expression 'population studies' is used to indicate the simpler and more descriptive demographic work. There is, however, no sharp dividing line between the various parts of demography and these expressions are used, if at all, without much consistency. In this matter, as indeed in all questions of definition, the student who wishes to pursue the question further would do well to refer to the English part of the *Multilingual Demographic Dictionary* published by the United Nations Organization.

The following definition of demography was given by Hauser and Duncan: 'the study of the size, territorial distribution and composition of population, changes therein, and the composition of such changes, which may be identified as natality, mortality, territorial movements and social mobility (change of status)'. This definition introduces several ideas not mentioned above. First, there is territorial distribution – evidently a matter of much importance. This characteristic was not mentioned in § 1.2, because 'population' was used in the sense of 'any group of people' and not a specific group such as the citizens of a town or nation. If any group of people can be chosen for study, then one can select those living in a particular area: hence the idea of territorial distribution is not, strictly speaking, needed as a basic concept. Similarly, other forms of population composition, for instance in respect of occupation, type of dwelling or religion, while very significant in demography, are not perhaps essential for mention in an initial definition. Nevertheless, they enter into a good deal of demographic work. Hauser and Duncan have emphasized that by the word 'composition' they intend the inclusion of

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'quality', for example, sex, social status, intelligence, and physical characteristics such as height.

Few, if any, people limit their studies to demography alone. Most persons who are interested in population are concerned also with other disciplines, notably actuarial science, agronomy, economics, economic geography, history, human biology, social policy, and sociology. In all of these it is useful to have knowledge of one or more aspects of demography. For instance, in economics, population size and distribution are clearly factors affecting total production and consumption. Social policy is influenced by the relative numbers of infants, children, young adults, people in middle life and the aged. Human biology is concerned *inter alia* with reproduction, birth control, the sex ratio and genetic constitution; population data are useful in connexion with all these subjects.

1.5 The parts of demography and their interrelationship

A diagram has been prepared in order to show how the various aspects of population study are related, and this appears as fig. 1.1. It will be seen that there are nine separate boxed subjects and that some links between them are indicated. Central to the diagram is the analysis of data of population movements, which has connexions with all the other topics. A prerequisite is the

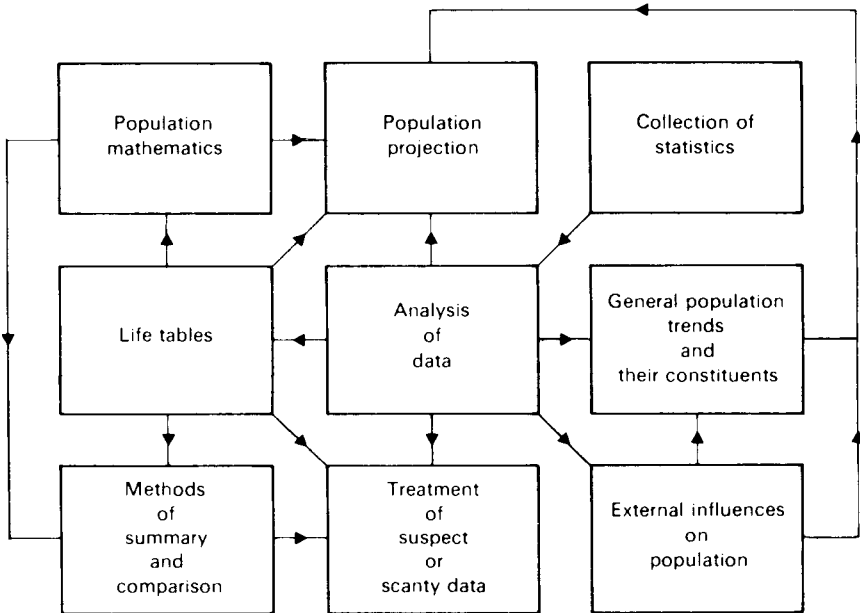


Fig. 1.1. Principal connexions between the main topics of demography.

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collection of statistics and this is therefore an inflow, but five other connections are shown as well, all as outflows, or consequences:

(a) analysis throws light on general population trends, mainly through their constituents of fertility, mortality and migration;

(b) the effects of external influences acting on population movements, such as social changes and economic progress, should be revealed as part of the analysis;

(c) one product is the preparation of life tables;

(d) another is projections of population into the future on the basis of assumptions derived from analysis;

(e) finally, the demographer's studies may show that the data are suspect or incomplete, but there are means by which he can correct for this (some of which derive from life tables).

Other links in fig. 1.1 relate to population mathematics, which although capable of being pursued entirely in the abstract almost always has a connexion with life tables; mathematics can well provide a basis for population projection, and it also helps with methods of summary and comparison, which derive from data analysis mainly through the medium of life tables. Finally, both general population trends and the influences which act upon them must clearly play an important part in population projection.

1.6 The contents of the chapters to follow

Not all the aspects of demography dealt with in this book find a place in the diagram. The introductory and concluding chapters, in particular, necessarily have links with every one of the nine topics displayed, and therefore figure all through it. Chapter 2 deals with some basic concepts of demographic analysis, which pervade the whole of the science; and chapter 3 explains some of the essential characteristics of the statistics, which must always be borne in mind. Finally, chapter 20 discusses the past, present and future of demography as a whole – a subject which can hardly be properly introduced until all the constituent parts have been elucidated.

When there are so many interconnexions, various orders are possible for the presentation of the topics but the most logical sequence for instruction purposes seems to be as follows. First, there is the collection of statistics in practice (chapter 4). Then it is desirable to list the principal characteristics of fertility, mortality and migration. Each of these principal demographic events has its own individual features, and there is a good deal of variation in nature from one to another – in respect of both the techniques used and the theoretical orientation and interest of the people who specialize in their study. The nature of the available data varies correspondingly, and the way in which the characteristics of these vital events can best be exhibited is peculiar to

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each one. It is the purpose of chapters 6, 7 and 8 respectively to illustrate these differences and to show how each type of occurrence can best be studied. The subject of marriage is treated first in chapter 5 because its associations with fertility are closer than those with mortality or migration. In the course of these chapters some typical results to be obtained from the analysis of vital events are shown by way of illustration.

1.7 Population trends and the influences upon them

At this stage it is useful to speak of the selection of bases for population projection, which normally derive directly from the analysis of trends in the constituent elements of marriage, fertility, mortality and migration: see chapter 9.

After this, the time has arrived for a look at how populations have actually developed, first in the past – often scantily recorded; secondly, in the present state of affairs, for which there are fuller particulars. Chapters 10 and 11 are given over to these respectively. They lead naturally to an investigation of such general influences upon population development today as resources, in the widest sense of the word, and governmental policies. In order to give the student an elementary introduction to these wider problems, two chapters are devoted to (*a*) population and resources (chapter 12) – the extent to which the world's people are fed, clothed and provided with other necessities of life – and (*b*) the policies of governments towards population, and in particular the issue of family planning (chapter 13). It is then of value to consider some of the demographic projections that have been made in recent years, and the prospects they suggest; this is the subject of chapter 14.

1.8 Formal demography

The ensuing five chapters are concerned with the use of methods of a mathematical nature, mainly in circumstances of deficient or non-existent population data but also when they are plentiful. Demographic data tend to be very voluminous; it is therefore necessary to be aware of the best methods by which their main characteristics can be noted and exhibited simply and concisely. A number of different methods of summarization exist, and any one of them is liable to conceal some important quality of the data. It is therefore necessary to be aware of the limitations of these methods. Chapter 15 deals with life-table techniques. Other systems of summary and comparison are touched on in chapter 16.

Because demographic trends are important in economic and social life, and because of the desire to plan ahead, there is much demand for estimates of future population. This demand persists in spite of the fact that it has not so far proved to predict the future at all accurately. Given a set of assumptions

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as to the course of mortality, fertility and migration over the coming decades, it is a fairly straightforward matter to work out the consequences for population size and age-distribution, and general methods by which this may be done are discussed in chapter 17. Some basic mathematics is given in chapter 18. Demography does not lend itself very readily to advanced mathematical treatment, and yet one aspect – the stable population theory developed by Lotka – is important historically, and indeed generally today. An elementary introduction to this theory, and to other proposed mathematical systems, is given in this chapter. The practical limitations are also made plain.

Chapter 19 is given over to the problems that arise, mainly in the economically less-well-developed countries, where statistics of one kind or another have been collected but these data may be, and indeed very probably are, unreliable. Methods of appraisal of credibility naturally assume a high importance in these conditions. In this chapter, a different area of uncertainty is also high-lighted: here data are difficult to come by because of the complexity and obscurity of the processes involved; for example in questions relating to the field of the biology of reproduction. Computer techniques, using simulation, have been developed in order that stochastic variability can be provided for in several stages. This is a rapidly developing area of demography, and prospects for future progress are almost as important as the work already done.

1.9 Conclusion

So diverse are the contents of *Demography* that it would seem of little value to try to summarize them concisely in the last few pages of the book. Instead, chapter 20 shows the limitations of what the student has read in the foregoing text; it does so by indicating some of the principal matters to which present-day research is being directed. In other words, attention is paid to the areas of the subject to which thought might usefully be devoted by those who wish to pursue their demographic studies further, after attaining basic proficiency in population analysis. The principal organs of demographic literature are also referred to – the broadening scope of the subject is indicated by the increasing number and length of writings upon it that appear from year to year.

SELECT BIBLIOGRAPHY

(*Note:* As in previous editions, the purpose of the reading lists at the end of each chapter is to indicate the names of a few of the works which contain some reference to the topics mentioned in the chapter and which may be generally useful to the student. The books and papers mentioned are not arranged in order of importance.)

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- Eldridge, Hope T. *The Materials of Demography: a Selected and Annotated Bibliography* (International Union for the Scientific Study of Population, and Population Association of America, New York, 1959).
- Hauser, P. M. and Duncan, O. D. *The Study of Population: an Inventory and Appraisal* (University Press, Chicago, 1959).
- Multi-lingual Demographic Dictionary: English Volume* (United Nations Organization, New York, 1958).

2 Demographic analysis: some basic concepts

2.1 Observation

The purpose of this chapter is to explain the fundamental nature of population analysis and to give an introduction to some of the necessary statistical methods. The object of study is the demographer's fellow creatures, and he has perforce to respect the rights of individuals and groups. Fully-controlled scientific experiments of the kind that are conducted in laboratories are out of the question. If inquiries become too inquisitorial they may well be rendered ineffective by refusals to respond, by evasions or by untruths. All the demographer can do is to observe the course of events from time to time, open as they are to many conflicting influences acting concurrently. He can be said to have access to 'experimental situations' in the sense that different populations can be studied at the same time, and the same population at different times, so that the effects of the intervention of different variables can be assessed. Nevertheless, interpretation of cause and effect, if this is at all possible, requires considerable skill and judgment, and there may be differences of opinion even between acknowledged experts. Above all, care is required, because it is all too easy to draw the wrong conclusions.

2.2 Objectives

The aim of analysis in demographic work is to identify and measure as precisely as possible the influences that underlie population changes. By so doing it is possible to deepen one's understanding of the variations observed in past experience, and also perhaps to arrive at a basis for the prediction of future trends. There must always, however, be some doubt about the chances that identified influences will continue to have effect in the years to come. Even if a simple extrapolation of an existing trend is accepted as a valid assessment for the future, it should be possible, as the result of prior analysis, to attach some rough measure of confidence to the estimation.

The word 'trend' is often misused. In the world of fashion it frequently implies no more than whatever style happens to be current. More correctly, it refers to a change in time; thus, if the proportion of old people in a population had been 20 per cent fifteen years ago, and 30 per cent at this year's

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census, then clearly there had been, over this period, an ageing trend. The trap into which many are liable to fall is to assume that this trend *must* continue. In fact, analysis is usually required in order to find out whether or not this is likely to happen. The main tasks of the demographer are, first, to understand the characteristics of his data; secondly, to observe and measure the past experience; thirdly, to study as far as possible the factors influencing the experience and causing the changes; and fourthly, to consider the prospects. In the third and technically most difficult stage, the analysis should be supplemented by an examination of any available information of a social, economic or even psychological kind that could indicate, or illustrate, the background.

2.3 Variations

Great precision is rarely justifiable in demography. Indeed, the observed statistics are subject to considerable variations, both in time and from one group or area to another. Whereas much of mathematical statistics is founded upon some assumption of homogeneity, in the study of population this assumption is rarely justified; frequently, observed variations greatly exceed those to be expected by statistical theory, and the actual fluctuations where large numbers are involved can be as big, relatively, as the random variations observed in small homogeneous groups. Consequently, the refinements of mathematical statistics are only of limited application in practical demography.

2.4 Classification

Population data are normally available on a standard pattern for different groups of people. Some obvious examples are males and females, young and old, working and not working, those in one area and those in another. Further subdivisions are usually possible; thus age can be measured in completed years, or even in months or days. Those not at work can be analysed into those too young for schooling, those at school, the unemployed, the retired, and so on, while people with a job can be classified into employers, managers, the self-employed and the employed. Analysis can be made by more than one characteristic at a time, as in table 2.1. Here, the grouping is two-fold, viz. by status and date. It would not be unusual to see a three-fold analysis, including (say) a breakdown by sex, or even a four-fold analysis (say) including also particulars of age or area. As the table cannot conveniently be presented in more than two dimensions, a wider spread over the page is necessary, and this can be achieved in a variety of ways, e.g. by the printing of two tables in a form similar to that of table 2.1, one for men and one for