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Every individual is some particular age. Populations are collections of individuals, and rather than being some particular age, they are characterized by the frequency distribution of the ages of the individuals who compose them. This is called the population age distribution or age structure. The age structure can be summarized in various ways, for example by the average or median age of the population. A population with a low median age is called young, and one with a high median age is called old. We can also define life cycle stages, such as youth, working ages, and old age, and describe the age structure by the percentage of the population in each of these categories, for which various boundaries are used: below age 15 or 18 or 20; between this age and 60 or 65; and above this upper age. Percentages of the population in each stage are also used to describe an age structure. Using these same life cycle stages, so-called dependency ratios may be formed. The ratio of the elderly to the working age population is the old age dependency ratio, the ratio of youth to the working age population is the child or youth dependency ratio, and the sum of these two is the total dependency ratio.

Some of these measures are shown below for the historical period 1950 to 2000, along with United Nations’ projections to the year 2050, for the more developed countries (DC) and the less developed countries (LDC), defined by their economic status in 2000. In every year, the DC countries have a higher median age than the LDCs, with a smaller proportion of children and a higher proportion of elderly. Evidently, aging has already affected the LDCs as well as the DCs; the phenomenon is not restricted to the industrial nations. The past and future aging of the DC populations is shown by the increase in their median age by 18 years from 1950 to 2050, and for the LDC populations by an increase of 14 years.

	1950	1975	2000	2025	2050
Median Age (yrs)					
DC	28.6	30.9	37.4	44.1	46.4
LDC	21.4	19.4	24.3	30.0	35.0
% <15					
DC	27.3	24.2	18.3	15	15.5
LDC	37.6	41.1	32.8	26	21.8
%≥60					
DC	11.7	15.4	19.4	28.2	33.5
LDC	6.4	6.2	7.7	12.6	19.3

Source: United Nations, 2002.

The age structure is shaped by the past history of births, and by the past age distributions of deaths and net migrations (Coale, 1972). Let us first consider the case in which net migration is always zero at all ages (a closed population, on net), and age specific fertility and mortality have been unchanging for a long time, say a century or more. In this case, it has been proven that the population will converge to a so-called stable population, in which the percentage age distribution is constant, and the population and every age group grow at the same constant exponential rate. Furthermore, this stable population age distribution is independent of the initial population age distribution at any time sufficiently long ago, again let us say a century. That is, the particular features and shape of the initial age distribution tend to be forgotten as time passes, and the eventual age distribution depends only on the constant age specific rates. Note that a stable population can have any constant growth rate, positive, negative or zero. A stationary population is a stable population with a zero growth rate.

Members of a population who are now age x were born x years ago, and have survived for x years. In a stable population, the number of births grows at the exponential population growth rate, call it r. In a growing population, the number of births x years ago will be smaller than the number of births today, and the more rapid the population growth rate, the smaller will be the generation born x years ago relative to today. The opposite will be true if the growth rate is negative and population is shrinking. Since the old people of today were born long ago, it follows that the more rapid the stable population growth rate, the smaller the share of the elderly in the population today. Indeed, the rate of population growth is the most important determinant of the age distribution of a closed, stable population. However, the age distribution is also determined mortality, which determines the proportions of births that survive to each age x. The lower is mortality, the higher will be the proportions surviving from birth to older ages.

Based on this discussion, we can see that higher fertility will always lead to a younger population by making it grow faster (Coale, 1972). Mortality, however, has two contradictory effects. On the one hand, lower mortality makes a population older by increasing the proportions surviving from birth to older ages. On the other hand, lower mortality tends to make a population younger, because it raises the population growth rate (for a given level of fertility). When the initial level of mortality is high, the net outcome of lower mortality is to make a stable population younger. When the initial level of mortality is low, lower mortality tends to make a population older (Lee, 1994). For intermediate initial levels, the effects of lower mortality are mixed, sometimes leading both to higher proportions of youth and of elderly, and sometimes hardly changing the age distribution at all. These different effects of mortality decline are observed in real world situations as well as in the hypothetical stable population simulations. For example, the table shows that the LDC population in 1975 had a younger median age than it did in 1950, as well as a higher proportion of children and lower proportion of elderly, illustrating how falling mortality can make a population younger.

Many actual population age distributions are highly irregular, rather than smooth and geometric like those of stable populations. Irregular distributions can come about in several major ways. A number of industrial country populations experienced a baby boom from the late 1940s through the mid 1960s, followed by baby busts and low fertility subsequently. These created large bulges and hollows in the population age distributions as the birth cohorts moved through the age distribution, with important consequences for their wages, unemployment rates and prospects for promotion, and eventually leading to fiscal pressures through public pension and health care systems. Population age distributions can also be heavily marked by sharp crises such as WWII or China's disastrous Great Leap Forward. Such crises cause heavy mortality that is sometimes concentrated at certain ages, and they also lead to sharp reductions in fertility and therefore in the size of generations born during and immediately after the crisis. When a population age distribution is strongly distorted by influences such as these, the distortions simply age with the population, moving up from younger to older ages as time passes. The effects of both WWI and WWII are still clearly apparent in the age pyramids of many European countries, for example. A third cause of irregular age structure is age-focused patterns of immigration and emigration. These are more frequently seen at the local than the national level. Often such patterns occur in towns with universities, prisons, army bases, or retirement communities. A fourth cause is emigration of the younger population from some rural areas, leaving behind an elderly population.

Not only do distorted age structures persist due to normal aging; they also can be transmitted to the stream of new births through normal processes of reproduction, as echoes. If some generations are unusually large, due to an earlier baby boom, for example, then when they enter peak reproductive ages they will themselves bear an unusually large number of births, given typical levels of fertility. In this way they would create another bulge in the age distribution, somewhat smaller than the first. Formal analysis shows that populations with non-stable age distributions but subject to constant age specific fertility and mortality will tend to move in cycles about one generation long (25 to 30 years) as they converge to stability. This result generalizes to populations that are constantly subjected to random perturbations, and historical time series of baptisms often show evidence of such cycles. Sometimes, however, there is negative feedback in the renewal process, so that large generations of young adults experience adverse economic conditions and consequently have lower fertility and give birth to smaller, rather than larger, generations. In this way cycles longer than one generation may be generated, known as Easterlin Cycles.

There is particular interest and concern about the process of population aging and rising old age dependency ratios, since these will affect the cost per worker of supporting the elderly retired populations. Some analysts and governments seek to raise fertility in order to reduce and postpone population aging. Another proposal is to alleviate population aging through increased immigration, since immigrants are typically younger than natives and have higher fertility. Analysis shows that any gains from such a policy would be short lived and smaller than most people expect, since immigrants grow old themselves and require support. Only constantly accelerating rates of immigration achieve much effect, and such policies cannot be sustained for long. As an example, the US Census Bureau reported the old age dependency ratio and median age in 1995 to be .21 and 34.3 years. They projected these quantities to the year 2050 under low and high immigration assumptions that differed by more than a million immigrants per year. With low immigration, the old age dependency ratio would rise by 2050 to .38 and the median age to 38.8 years. With a million more immigrants per year, these would be only slightly lower at .35 and 37.6 years. The additional 55 million immigrants have a big effect on population size, but only a small effect on population aging.

Population age distributions have a range of socio-economic consequences, because people's behaviors, abilities, and entitlements all vary with age (Lee, 1994). These variations reflect biological changes over the life cycle, but in addition they reflect somewhat arbitrary institutional age categories and individual choices in response to various preferences and incentives. On the biological side, it appears that health and vitality are increasing at the older ages, so that work life could be extended to older ages. However, this option is apparently not viewed as desirable, since actual ages at retirement have declined sharply in recent decades, often by as much as five years as in the US. These declines are due in part to the desire for more leisure as incomes rise, pensions become more common, and financial institutions make saving easier. However, it is also clear that the structure of both public and private pensions provides strong incentives for early retirement, and that this has contributed to the decline.

The boundary age for dependency in youth reflects a similar list of factors which influence the age at moving from education into the workforce. These age boundaries for youth and old age correspond roughly to directions of flows of intergenerational transfers, through the family and through the public sector. The public sector in industrial countries provides pensions and health care for the elderly, and education for youth. The size of these public transfer programs for the young and the old swamps the transfers to those of working age. Private transfers in most industrial nations are mainly parental support of children, and transfers from the elderly to assist their adult children and as bequests when they die.

As the population age distribution changes, pressure on those who make these transfers is relaxed or intensified. Population aging often goes with a reduced need for public and private transfers to children, but a greatly increased need for transfers to the elderly for health care and pensions. We can calculate a generalized fiscal dependency ratio by weighting each population age group in the numerator by the costliness of public transfers it receives, and in the denominator by the level of taxes it pays. Holding these weights fixed, we can then see how the fiscal dependency ratio changes over time for demographic reasons alone. For the US, the federal fiscal support ratio is projected to increase by 56% over the next 75 years. This means that in order to provide the same set of age-specific benefits as today, taxes would have to be raised by 56%. Alternatively, if age specific tax payments were held constant, then benefits would have to be scaled back by 36%.

References

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