CHAPTER 1
Demography – impact of an expanding elderly population

S. Jay Olshansky
School of Public Health, University of Illinois at Chicago, Chicago, IL, USA

Introduction

Scientists who study the demography of aging investigate trends in, and characteristics of, fertility, mortality and migration and how these components of population change influence, and are influenced by, the environments in which people live. This is a new area of scientific inquiry because aging, as a uniquely demographic phenomenon of populations, has been experienced on a large scale by only one species – humans – and even then only for the last century. Among the many social and economic changes that population aging has brought forth, one of the most important has been dramatic increases in the absolute number of people who live into older regions of the lifespan – a phenomenon that will accelerate in the coming decades.

It is important to understand the difference between population aging and individual aging. Individual aging refers to the biological changes that occur in our cells, tissues and organs with the passage of time, and it is measured demographically at the level of the individual by the duration of our lives. By contrast, population aging is characterized by shifts in the age structure of groups of people such that the relative proportion of older persons (often defined by those aged 65 and older) increases in relation to the number of people under the age of 65. The most common measures that are used to track changes in population aging across time or between population subgroups include the median age, expected remaining years of life (i.e. life expectancy) at middle and older ages and the percentage of the total population aged 65 and older.

Causes and consequences of population aging

For most of recorded history there has been a consistent (stable) pattern of fluctuating birth rates and death rates. Until about the middle of the 19th century, death rates had consistently fluctuated between peaks and troughs as a result of communicable diseases that periodically decimated populations, followed by times of relative stasis. Birth rates were extremely high during most of human history. On average, women gave birth to about seven babies during their reproductive years. Many of the children died in their first year of life from communicable diseases, but death rates were also extremely high throughout the age structure. In fact, the risk of death was so high at middle and younger ages that survival into older ages (beyond age 65) was a rare event by comparison to survival patterns observed today. Living into extreme old ages (ages 85 and older) was an extremely rare occurrence. Since birth rates have almost always exceeded death rates by a small margin throughout most of our history, the size of the human population has grown steadily for thousands of years.

If you were to count the number of people alive at all ages in a given year and plot them on a graph, what you would see is a characteristic age distribution that resembles the shape of a pyramid (see Figure 1.1). This is a common age pattern among humans and many other forms of life where there are a large number of young followed by progressively fewer middle aged and older members of the population. In a hypothetically closed population with no migration, the horizontal bars in the age pyramid reflect the number
of people surviving to each age range from an original birth cohort based on prevailing death rates. However, in an open population with migration and changing vital rates (which reflect the true nature of living conditions), the age pyramid reflects historical patterns of fertility, mortality and migration. The age pyramid is what characterized the human age distribution throughout most of our history, but this changed rapidly during the 20th century.

During the last 100 years a combination of events led to dramatic changes in the stable patterns of birth rates and death rates that had likely existed for thousands of years. Advances in public health led to the availability of clean water and refrigeration, sewage disposal and improved living and working environments. These developments combined with modern medicine to significantly reduce the transmission of, and death rate from, air- and water-borne infectious diseases. Within a single generation the environmental conditions that permitted the easy transmission of diseases that killed infants and children and women during childbirth were profoundly altered. From a biological perspective, modifications of this magnitude and importance suggest that fundamental changes in the forces of natural selection operating on the human species had occurred.

As the risk of death at younger ages declined rapidly, the high birth rates that were needed to replace the children who died from infectious diseases began to subside. Since the decline in birth rates lagged behind the decline in death rates, the result was rapid population growth during the 20th century – from one billion in 1900 to more than 6.5 billion by the turn of the 21st century. The eventual transformation of birth rates and death rates to the lower levels now observed in most developed nations is what set the stage for the demographic phenomenon of population aging.

When death rates declined at younger ages, the base of the age pyramid expanded and its apex became smaller by comparison. When the apex of an age pyramid decreases relative to its base, it may be said that a population is becoming younger. Thus, the first demographic consequence of declining early-age mortality was a younger population. However, within a single generation those saved from dying at younger ages began to reach middle and older ages, thereby altering the population’s age composition by increasing the size of the middle and apex of the age pyramid relative to its base (see Figure 1.2). When death rates at younger ages stabilize at extremely low levels, as they have in all countries with high life expectancies, the base of the age pyramid then becomes sensitive only to changes in birth rates. With a stable base and a growing middle and apex, a permanent shift in the age structure occurs from its historical pyramid shape to that of a square-like or rectilinear form. Although temporary increases in birth rates (like those observed in the post-World War II era) can slow population aging and even temporarily reverse it, the new rectilinear age structure will eventually reassert itself as the children from the larger birth cohorts survive to older ages. The transformation from stable birth and death rates to stable low birth and death rates has led to permanent changes in the age structure of the human species.

![Figure 1.1](image1.png) Age pyramid for humans in Nigeria in the year 2000. Source: United Nations, 2001.

![Figure 1.2](image2.png) Age pyramid of the future with a shift in the historical pyramidal shape to that of a square-like or rectilinear form. Source: United Nations, 2001.
The social, economic and health implications associated with population aging are profound. Consider an ongoing debate in the health and demographic sciences known as the compression versus expansion of morbidity hypotheses. When death rates decline at younger ages the proportion of each birth cohort surviving past ages 65 and 85 increases rapidly. By way of example, in France the proportion of the female birth cohort of 1900 that was expected to survive to ages 65 and 85 based on death rates in that year was 39% and 3.5%, respectively. By comparison, the female birth cohort of 2000 is expected to have 90% and 50% survive past ages 65 and 85, respectively. These unprecedented patterns of survival into older ages are now common throughout the nations of the developed world, and they have led scientists to track the health of these aging pioneers and how prospective changes in death rates at older ages might influence the future health of the older population.

One school of thought argues for what has come to be known as the compression of morbidity hypothesis. With this hypothesis it is suggested that lifestyle changes and advances in medicine will continue to reduce the risk of death from fatal diseases and simultaneously lead to a postponement in the onset and age progression of the nonfatal disabling diseases. The premise of this theory is that there is a fixed biological limit to life towards which populations are headed, and as improved lifestyles successfully postpone the onset and expression of fatal diseases and nonfatal but highly disabling diseases and disorders, more people will be pushed towards their biological ‘limit’ to life, and morbidity and disability will be compressed into a shorter duration of time before death.

A second school of thought proposes what has come to be known as the expansion of morbidity hypothesis. The proponents of this hypothesis maintain that the forces influencing the onset and age progression of nonfatal diseases associated with senescence are mostly independent of the forces influencing the risk of death from fatal diseases. If death rates from fatal diseases continue to decline, it is hypothesized that the saved population will be exposed to a longer duration of time during which the nonfatal but highly disabling diseases and disorders of senescence have the opportunity to be expressed. In other words, the extension of life resulting from continued progress made against fatal diseases is hypothesized to eventually prolong the period of disability in old age among future cohorts of older persons.

A debate has taken place in the scientific literature regarding these two important hypotheses. Although the evidence suggests that in the 1980s several countries were experiencing an expansion of morbidity, since then there is evidence to suggest that some compression has been occurring. However, research in this area should be interpreted with caution because empirical studies addressed to this debate have focused on health transitions observed only during the recent past (since 1980). It is distinctly possible that future cohorts of older persons will be notably different in many ways from current older generations because of the high degree of selection that occurred among people living to older ages in today’s world. Furthermore, it is not possible to know with any degree of certainty whether the health status of future cohorts of older persons will be better or worse than previous cohorts passing through the same ages.

**Relationship between individual aging and population aging**

The transformation of birth rates and death rates to currently stable low levels was caused, in part, by the same forces of declining mortality that contributed to unprecedented increases in life expectancy. During the Roman Empire life expectancy at birth was estimated to be about 28 years. By 1900 life expectancy for men and women combined had increased to 45 years in the nations with the lowest death rates at that time, but by the 21st century life expectancy at birth has risen to between 75 and 80 years. Most of the gains in life expectancy during the mortality revolution of the last century are a product of declining early age mortality, but notable reductions in middle and old age mortality have been observed in recent decades. In today’s high life expectancy populations of North America, Western Europe, Scandinavia and Japan, death rates at younger ages have declined to such low levels that 98 out of every 100 babies born will live past the age of thirty.

As life expectancy continues to rise due to further expected reductions in middle and old-age mortality, survival into increasingly older regions of the lifespan by larger segments of the population is inevitable. Thus, life-extending technologies and lifestyle modification that bring forth declining death rates contribute to population aging by further expanding the apex of the age pyramid relative to its base. How much higher life expectancy can rise is a question of great interest and debate among scientists today, but one thing most can agree on for now is that population aging is an inevitable demographic phenomenon that will be accelerated by anticipated reductions in the risk of death.

**Population aging and geriatric dentistry**

In the last century the unprecedented aging of humanity has enabled modern populations to witness something that was rarely observed in the history of our species – old age and
the diseases and disorders that accompany it, as well as the wisdom and benefits that accompany healthy survival into regions of the lifespan rarely experienced by our ancestors. At one level we have taxed our bodies to their limits, exposing our joints, muscles, bones, teeth and brains to decades more use than any previous human population. We have come to better understand the limitations of our bodies and how some components, such as neurons, muscle fibers and tooth enamel, do not replicate during the course of life. In a very important way, some components of our bodies that are critical to survival, such as muscles and neurons, represent limiting factors that will preclude a further dramatic extension of life unless it becomes possible to alter their rates of decline with age. However, we have also come to learn that there is no aging or death program for humans, which means that in many important ways it is possible to influence the way in which we age as individuals, and thus the degree to which individual aging influences population aging.

Dentistry will influence, and will be affected by, the demographic phenomenon of population aging and its antecedent causes in several ways. Population aging is defined, in part, by the extension of the lives of millions of people into their 8th, 9th and 10th decades of life who would ordinarily have never lived that long had they not been born in the modern era. As the extremely large baby boom cohorts of the post-World War II era move through the age structure and reach retirement ages, the unique health care needs of this population are going to challenge health care systems across the globe. The demand for geriatric dentistry will parallel the rising demand for all of the health care fields. It is also worth noting that younger generations might need less geriatric dentistry as they grow old since these birth cohorts were exposed to fluoridated water.

At one level, dentistry is unique in public health because it is known that, with sufficient preventive maintenance, it is possible to retain our teeth at a high level of functional performance for most of our lives. In other words, it may very well be possible that among most people, when properly maintained, teeth can outlast most other components of the human body. The same cannot be said for muscle mass and neurons, both of which are known to respond well to use, but which still experience significant functional declines no matter how hard we try to maintain them at younger ages. Furthermore, even with the loss of our natural teeth, it is possible to indefinitely maintain functionality with prosthetics. The same cannot be said for most other parts of the body.

Dentistry is also unique in its effect on population aging because primary prevention practiced in our early and middle ages can not only help to maintain oral health, such practices may also reduce the risk of a number of chronic fatal diseases throughout life – the most important among them is heart disease. Thus, the field of dentistry has the potential to reduce the risk of death at older ages, extend the duration of life, and thereby further accelerate the demographic phenomenon of population aging. However, geriatric dentistry in the 21st century will not be without its challenges. With many more people living into extreme old ages (e.g. beyond age 100) where only a small segment of the population used to survive, geriatric dentistry will face health issues associated with the systemic aging of other components of the body – most notable among them are bone density and immune surveillance.

Like many other public health fields, dentistry will be profoundly influenced by the demographic changes in the population that have already taken place and those that are forthcoming. It may very well be true that the health and aging of the entire body is visible through the lens of the mouth, so dentists have the ability to monitor the health status of their patients at a higher level of frequency than primary care physicians. Dentistry in the 21st century will maintain its position as a central component to public health and will no doubt further contribute to the extension of life and an anticipated acceleration in population aging.

Further reading


