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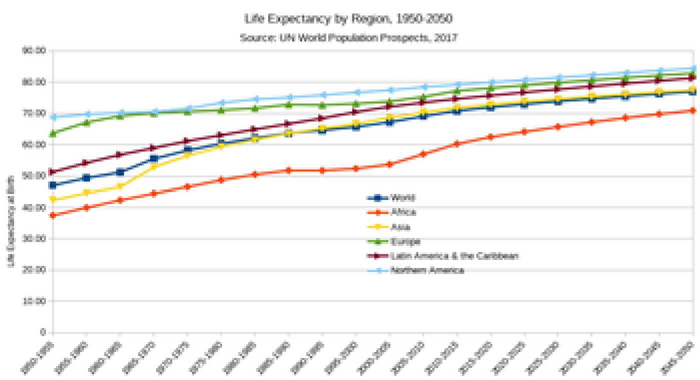
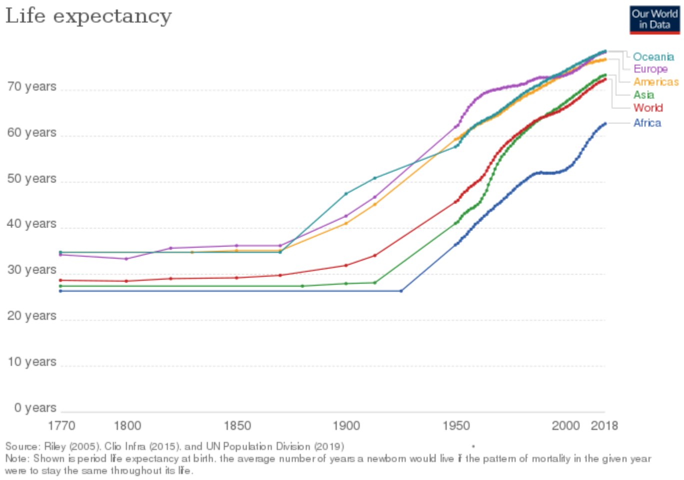
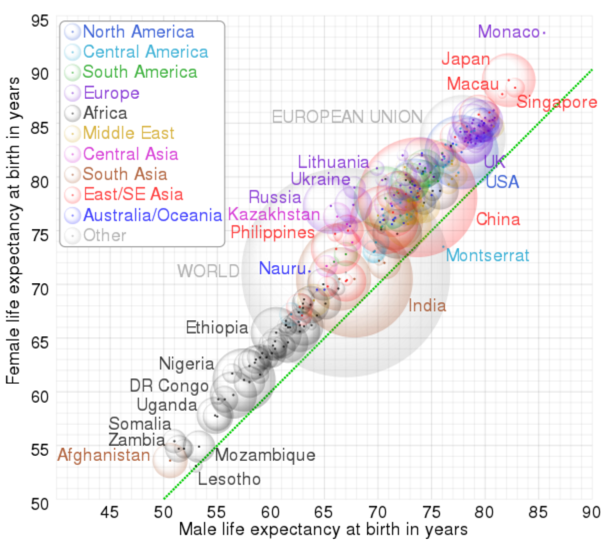
Life expectancy



Life expectancy at birth, measured by region, between 1950 and 2050



Life expectancy by world region, from 1770 to 2018



Gender Die Gap: global gender life expectancy gap at birth for countries and territories as defined in the 2011 CIA Factbook, with selected bubbles labelled. The dotted line corresponds to equal female and male life expectancy. The apparent 3D volumes of the *bubbles are linearly proportional to their population.*[1][2] *(In the SVG file , hover over a bubble to highlight it and show its data.)*

Life expectancy is a statistical measure of the average (see below) time an organism is expected to live, based on the year of its birth, its current age, and other demographic factors including gender. The most commonly used measure is **life expectancy at birth** (**LEB**), which can be defined in two ways. *Cohort* LEB is the mean length of life of an actual birth cohort (all individuals born in a given year) and can be computed only for cohorts born many decades ago, so that all their members have died. *Period* LEB is the mean length of life of a hypothetical cohort assumed to be exposed, from birth through death, to the mortality rates observed at a given year.[3]

National LEB figures reported by national agencies and international organizations for human populations are indeed estimates of *period* LEB. In the Bronze Age and the Iron Age, human LEB was 26 years; the 2010 world LEB was 67.2 years. For recent years, LEB in Eswatini (Swaziland) is about 49, while LEB in Japan is about 83. The combination of high infant mortality and deaths in young adulthood from accidents, epidemics, plagues, wars, and childbirth, particularly before modern medicine was widely available, significantly lowers LEB. For example, a society with a LEB of 40 may have few people dying at precisely 40: most will die before 30 or after 55. In populations with high infant mortality rates, LEB is highly sensitive to the rate of death in the first few years of life. Because of this sensitivity to infant mortality, LEB can be subjected to gross misinterpretation, leading one to believe that a population with a low LEB will necessarily have a small proportion of older people.[4] Another measure, such as life expectancy at age 5 (e_5), can be used to exclude the effect of infant mortality to provide a simple measure of overall mortality rates other than in early childhood; in the hypothetical population above, life expectancy at 5 would be another 65. Aggregate population measures, such as the proportion of the population in various age groups, should also be used alongside individual-based measures like formal life expectancy when analyzing population structure and dynamics. However, pre-modern societies still had universally higher mortality rates and universally lower life expectancies at every age for both genders, and this example was relatively rare. In societies with life expectancies of 30, for instance, a 40-year remaining timespan at age 5 may not have been uncommon, but a 60-year one was.

Mathematically, life expectancy is the mean number of years of life remaining at a given age, assuming age-specific mortality rates remain at their most recently measured levels.[5] It is denoted by e_x,[a] which means the mean number of subsequent years of life for someone now aged x, according to a particular mortality experience. Longevity, maximum lifespan, and life expectancy are not synonyms. Life expectancy is defined statistically as the mean number of years remaining for an individual or a group of people at a given age. Longevity refers to the characteristics of the relatively long lifespan of some members of a population. Maximum lifespan is the age at death for the longest-lived individual of a species. Moreover, because life expectancy is an average, a particular person may die many years before or many years after the "expected" survival. The term "maximum lifespan" has a quite different meaning and is more related to longevity.

Life expectancy is also used in plant or animal ecology,[6] and in life tables (also known as actuarial tables). The term and concept of life expectancy may also be used in the context of manufactured objects,[7] though the related term shelf life is commonly used for consumer products, and the terms "mean time to breakdown" (MTTB) and "mean time between failures" (MTBF) are used in engineering.

Human patterns

Maximum

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Records of human lifespan above age 100 are highly susceptible to errors.[8] For example, the previous world-record holder for human lifespan, Carrie White, was uncovered as a simple typographic error after more than two decades.[8] Therefore, the capacity for equivalent hidden errors make maximum lifespan records highly dubious. The longest verified lifespan for any human is that of Frenchwoman Jeanne Calment, who is claimed to have lived to age 122 years, 164 days, between 21 February 1875 and 4 August 1997, which however is disputed. This is referred to as the "maximum life span," which is the upper boundary of life, the maximum number of years any human is known to have lived.[9] A theoretical study shows that the maximum life expectancy at birth is limited by the human life characteristic value δ, which is around 104 years.[10] According to a study by biologists Bryan G. Hughes and Siegfried Hekimi, there is no evidence for limit on human lifespan.[11][12] However, this view has been questioned on the basis of error patterns.[8]

Variation over time

The following information is derived from the 1961 *Encyclopædia Britannica* and other sources, some with questionable accuracy. Unless otherwise stated, it represents estimates of the life expectancies of the world population as a whole. In many instances, life expectancy varied considerably according to class and gender.

Life expectancy at birth takes account of infant mortality but not prenatal mortality.

Era	Life expectancy at birth in years	Life expectancy at older age
Paleolithic	33	Based on Neolithic and Bronze Age data, the total life expectancy at 15 would not exceed 34 years.[13] Based on the data from modern hunter-gatherer populations, it is

		estimated that at 15, life expectancy was an additional 39 years (total 54), with a 60% probability of reaching 15.[14]
Neolithic	20[15] to 33[16]	Based on Early Neolithic data, total life expectancy at 15 would be 28–33 years.[13]
Bronze Age and Iron	26	Based on Early and Middle

Age[17]		Bronze Age data, total life expectancy at 15 would be 28–36 years.[13]
Classical Greece[18]	25[19] to 28[20]	Based on Athens Agora and Corinth data, total life expectancy at 15 would be 37–41 years.[13]
Classical Rome	20 to 30	Data is lacking, but computer models provide the estimate. If a

		person survived to age 20, they could expect to live around 30 years more. Life expectancy was probably slightly longer for women than men.[21]
Medieval Islamic world[22]	35+	Average lifespan of scholars was 59–84.3 years.[23][24][25][26]
Pre-Columbian	25–30	

Southern United States[27]		
Late medieval English peerage[28][29]	30	At age 21, life expectancy of an aristocrat was an additional 43 years (total age 64).[30]
Early modern England[17]	33–40	34 years for males in the 18th century.[31]
Pre-Champlain Canadian Maritimes[32]	60	Samuel de Champlain wrote that in his visits to Mi'kmaq and

		Huron communities, he met people over 100 years old. Daniel Paul attributes the incredible lifespan in the region to low stress and a healthy diet of lean meats, diverse vegetables and legumes.[33]
18th-century	24.7	For males.[31]

Prussia[31]		
18th-century France[31]	27.5–30	For males.[31]
18th-century Qing China[31]	39.6	For males.[31]
18th-century Edo Japan[31]	41.1	For males.[31]
19th-century British India[34]	25.4	
Early 19th-century England[17]	40	
1900 world	31	

average[35]		
1950 world average[35]	48	
2017 world average[36]	72.2	

Life expectancy increases with age as the individual survives the higher mortality rates associated with childhood. For instance, the table above listed the life expectancy at birth among 13th-century English nobles at 30. Having survived until the age of 21, a male member of the English aristocracy in this period could expect to live:[30]

- 1200–1300: to age 64
- 1300–1400: to age 45 (because of the bubonic plague)
- 1400–1500: to age 69
- 1500–1550: to age 71

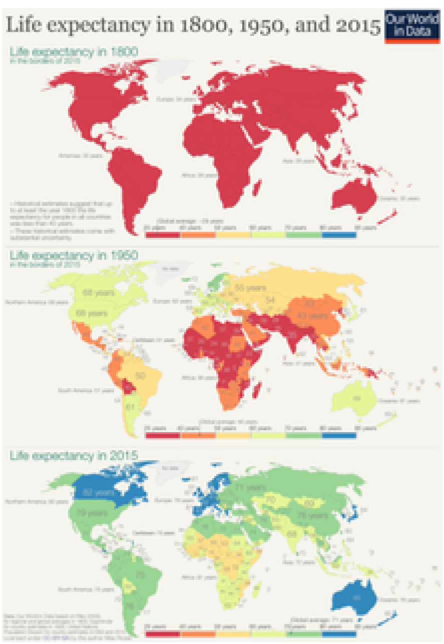
In a similar way, the life expectancy of scholars in the Medieval Islamic world was 59–84.3 years.[23][24][25][26]

17th-century English life expectancy was only about 35 years, largely because infant and child mortality remained high. Life expectancy was under 25 years in the early Colony of Virginia,[37] and in seventeenth-century New England, about 40 percent died before reaching adulthood.[38] During the Industrial Revolution, the life expectancy of children increased dramatically.[39] The under-5 mortality rate in London decreased from 745 (745 out of how many? 1,000? - needs clarification) in 1730–1749 to 318 in 1810–1829.[40][41]

Public health measures are credited with much of the recent increase in life expectancy. During the 20th century, despite a brief drop due to the 1918 flu pandemic[42] starting around that time the average lifespan in the United States increased by more than 30 years, of which

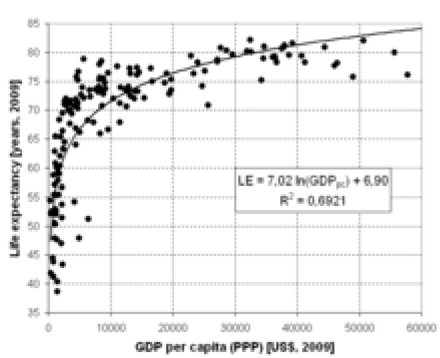
25 years can be attributed to advances in public health.[43]

Regional variations



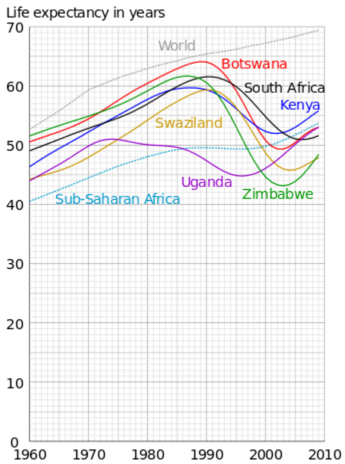
Life expectancy in 1800, 1950, and 2015 – visualization by Our World in Data

Human beings are expected to live on average 30–40 years in Eswatini[44] and 82.6 years in Japan, but the latter's recorded life expectancy may have been very slightly increased by counting many infant deaths as stillborn.[45] An analysis published in 2011 in *The Lancet* attributes Japanese life expectancy to equal opportunities and public health as well as diet.[46][47]



Plot of life expectancy vs. GDP per capita in 2009.

This phenomenon is known as the Preston curve.



Graphs of life expectancy at birth for some sub-Saharan countries showing the fall in the 1990s primarily due to the HIV pandemic.[48]

There are great variations in life expectancy between different parts of the world, mostly caused by differences in public health, medical care, and diet. The impact of AIDS on life expectancy is particularly notable in many African countries. According to projections made by the United Nations (UN) in 2002, the life expectancy at birth for 2010–2015 (if HIV/AIDS did not exist) would have been:[49]

- 70.7 years instead of 31.6 years, Botswana
- 69.9 years instead of 41.5 years, South Africa
- 70.5 years instead of 31.8 years, Zimbabwe

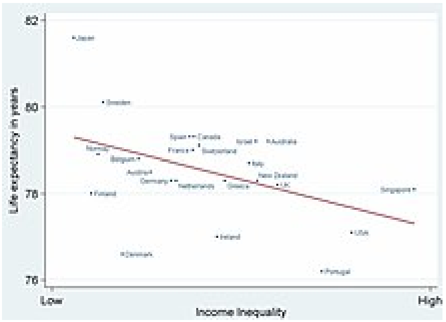
Actual life expectancy in Botswana declined from 65 in 1990 to 49 in 2000 before increasing to 66 in 2011. In South Africa, life expectancy was 63 in 1990, 57 in 2000, and 58 in 2011. And in Zimbabwe, life expectancy was 60 in 1990, 43 in 2000, and 54 in 2011.[50]

During the last 200 years, African countries have generally not had the same improvements in mortality rates that have been enjoyed by countries in Asia, Latin America, and Europe.[51][52]

In the United States, African-American people have shorter life expectancies than their European-American counterparts. For example, white Americans born in 2010 are expected to live until age 78.9, but black Americans only until age 75.1. This 3.8-year gap, however, is the lowest it has been since 1975 at the latest. The greatest difference was 7.1 years in 1993.[53] In contrast, Asian-American women live the longest of all ethnic groups in the United States, with a life expectancy of 85.8 years.[54] The life expectancy of Hispanic Americans is 81.2 years.[53] According to the new government reports in the US, life expectancy in the country dropped again because of the rise in suicide and drug overdose rates. The Centers for Disease Control (CDC) found nearly 70,000 more Americans died in 2017 than 2016, with rising rates of death among 25- to 44-year-olds.[55]

Cities also experience a wide range of life expectancy based on neighborhood breakdowns. This is largely due to economic clustering and poverty conditions that tend to associate based on geographic location. Multi-generational poverty found in struggling neighborhoods also contributes. In United States cities such as Cincinnati, the life expectancy gap between low income and high income neighborhoods touches 20 years.[56]

Economic circumstances



Life expectancy is higher in rich countries with low economic inequality[57]

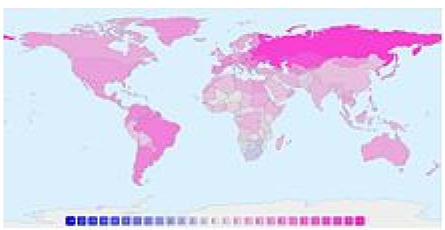
Economic circumstances also affect life expectancy. For example, in the United Kingdom, life expectancy in the wealthiest and richest areas is several years higher than in the poorest areas. This may reflect factors such as diet and lifestyle, as well as access to medical care. It may also reflect a selective effect: people with chronic life-threatening illnesses are less likely to become wealthy or to reside in affluent areas.[58] In Glasgow, the disparity is amongst the highest in the world: life expectancy for males in the heavily deprived Calton area stands at 54, which is 28 years less than in the affluent area of Lenzie, which is only 8 km away.[59][60]

A 2013 study found a pronounced relationship between economic inequality and life expectancy.[61] However, a study by José A. Tapia Granados and Ana Diez Roux at the University of Michigan found that life expectancy actually increased during the Great Depression, and during recessions and depressions in general.[62]

The authors suggest that when people are working extra hard during good economic times, they undergo more stress, exposure to pollution, and likelihood of injury among other longevity-limiting factors.

Life expectancy is also likely to be affected by exposure to high levels of highway air pollution or industrial air pollution. This is one way that occupation can have a major effect on life expectancy. Coal miners (and in prior generations, asbestos cutters) often have lower life expectancies than average. Other factors affecting an individual's life expectancy are genetic disorders, drug use, tobacco smoking, excessive alcohol consumption, obesity, access to health care, diet and exercise.

Sex differences



Pink: Countries where females life expectancy at birth is higher than males. Blue: A few countries in the south of Africa where females have shorter lives due to AIDS[63]

Female human life expectancy is considerably greater than that of males, despite females having higher morbidity rates, see Health Survival paradox. There are many reasons for this. Traditional arguments tend to favor sociology-environmental factors: historically, men have generally consumed more tobacco, alcohol and drugs than women in most societies, and are more likely to die from many associated diseases such as lung cancer, tuberculosis and cirrhosis of the liver.[64] Men are also more likely to die from injuries, whether unintentional (such as occupational, war or car accidents) or intentional (suicide).[64] Men are also more likely to die from most of the leading causes of death (some already stated above) than women. Some of these in the

United States include: cancer of the respiratory system, motor vehicle accidents, suicide, cirrhosis of the liver, emphysema, prostate cancer, and coronary heart disease.[9] These far outweigh the female mortality rate from breast cancer and cervical cancer. In the past, mortality rates for females in child-bearing age groups were higher than for males at the same age.

A paper from 2015 found that female fetuses have a higher mortality rate than male fetuses.[65] This finding contradicts papers dating from 2002 and earlier that attribute the male sex to higher in-utero mortality rates.[66][67][68] Among the smallest premature babies (those under 2 pounds or 900 g), females have a higher survival rate. At the other extreme, about 90% of individuals aged 110 are female. The difference in life expectancy between men and women in the United States dropped from 7.8 years in 1979 to 5.3 years in 2005, with women expected to live to age 80.1 in 2005.[69] Data from the UK shows the gap in life expectancy between men and women decreasing in later life. This may be attributable to the effects of infant mortality and young adult death rates.[70]

Some argue that shorter male life expectancy is merely another manifestation of the general rule, seen in all mammal species, that larger-sized individuals within a species tend, on average, to have shorter lives.[71][72] This biological difference occurs because women have more resistance to infections and degenerative diseases.[9]

In her extensive review of the existing literature, Kalben concluded that the fact that women live longer than men was observed at least as far back as 1750 and that, with relatively equal treatment, today males in all parts of the world experience greater mortality than females. Kalben's study, however, was restricted to data in Western Europe alone, where demographic transition occurred relatively early. In countries such as Hungary, Bulgaria, India and China, males continued to outlive females into the twentieth century.[73] Of 72 selected causes of death, only 6 yielded greater female than male age-adjusted death rates in 1998 in the United States. With the exception of birds, for almost all of the animal species studied, males have higher mortality than females. Evidence suggests that the sex mortality differential in people is due to both biological/genetic and environmental/behavioral risk and protective factors.[74]

There is a recent suggestion that mitochondrial mutations that shorten lifespan continue to be expressed in males (but less so in females) because mitochondria are inherited only through the mother. By contrast, natural selection weeds out mitochondria that reduce female survival; therefore such mitochondria are less likely to be passed on to the next generation. This thus suggests that females tend to live longer than males. The authors claim that this is a partial explanation.[75][76]

In developed countries, starting around 1880, death rates decreased faster among women, leading to differences in mortality rates between males and females. Before 1880 death rates were the same. In people born after 1900, the death rate of 50- to 70-year-old men was double that of women of the same age. Men may be more vulnerable to cardiovascular disease than women, but this susceptibility was evident only after deaths from other causes, such as infections, started to decline.[77] Most of the difference in life expectancy between the sexes is accounted for by differences in the rate of death by cardiovascular diseases among persons aged 50–70.[78]

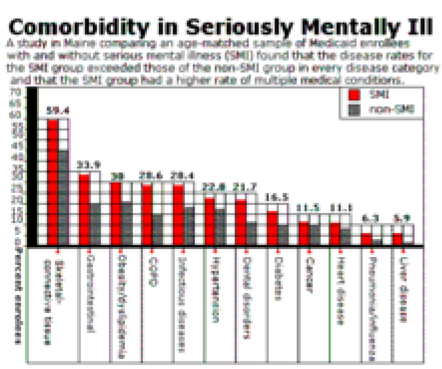
Centenarians

In developed countries, the number of centenarians is increasing at approximately 5.5% per year, which means doubling the centenarian population every 13 years, pushing it from some 455,000 in 2009 to 4.1 million in 2050.[79] Japan is the country with the highest ratio of centenarians (347 for every 1 million inhabitants in September 2010). Shimane prefecture had an estimated 743 centenarians per million inhabitants.[80]

In the United States, the number of centenarians grew from 32,194 in 1980 to 71,944 in November 2010 (232 centenarians per million inhabitants).[81]

Mental illness

Mental illness is reported to occur in approximately 18% of the average American population.[82][83]



Life expectancy in the seriously mentally ill is much *shorter than the general population.*[84]

The mentally ill have been shown to have a 10- to 25-year reduction in life expectancy.[85] Generally, the reduction of lifespan in the mentally ill population compared to the mentally stable population has been studied and documented.[86][87][88][89][90]

The greater mortality of people with mental disorders may be due to death from injury, from co-morbid conditions, or from medication side effects.[91] For instance, psychiatric medications can increase the risk of developing diabetes.[92][93][94][95] It has been shown that the psychiatric medication olanzapine can increase risk of developing agranulocytosis among other comorbidities.[96][97] Psychiatric medicines also affect the gastrointestinal tract, where the mentally ill have a four times risk of gastrointestinal disease.[98][99][100]

Other illnesses

The life expectancy of people with diabetes, which is 9.3% of the U.S. population, is reduced by roughly ten to twenty years.[101][102] Other demographics that tend to have a lower life expectancy than average include transplant recipients,[103] and the obese.[104]

Education

Education on all levels has been shown to be strongly associated with increased life expectancy.[105] This association may be due partly to higher income,[106] which can lead to increased life expectancy. Despite the association, there is no causal relationship between higher education and life expectancy.[105]

According to a paper from 2015, the mortality rate for the Caucasian population in the United States from 1993 to 2001 is four times higher for those who did not complete high school compared to those who have at least 16 years of education.[105] In fact, within the U.S. adult population, those who have less than a high school education have the shortest life expectancies.

Pre-school education also plays a large role in life expectancy. It was found that high-quality early stage childhood education had positive effects on health. Researchers discovered this by analyzing the results of the Carolina Abecedarian Project (ABC) finding that the disadvantaged children who were randomly assigned to treatment had lower instances of risk factors for cardiovascular and metabolic diseases in their mid-30s.[107]

Evolution and aging rate

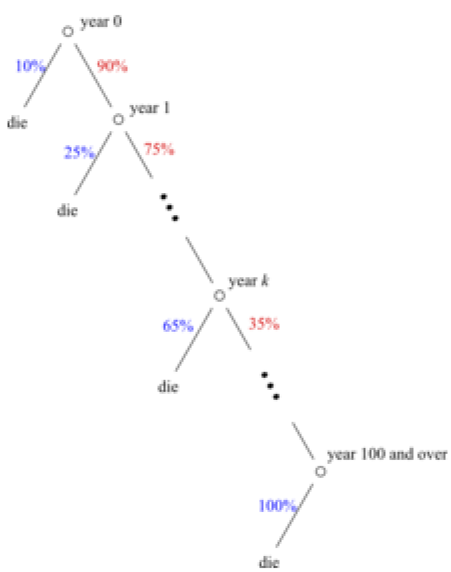
Various species of plants and animals, including humans, have different lifespans. Evolutionary theory states that organisms that, by virtue of their defenses or lifestyle, live for long periods and avoid accidents, disease, predation, etc. are likely to have genes that code for slow aging, which often translates to good cellular repair.

One theory is that if predation or accidental deaths prevent most individuals from living to an old age, there will be less natural selection to increase the intrinsic life span.[108] That finding was supported in a classic study of opossums by Austad;[109] however, the opposite relationship was found in an equally prominent study of guppies by Reznick.[110][111]

One prominent and very popular theory states that lifespan can be lengthened by a tight budget for food energy called caloric restriction.[112] Caloric restriction observed in many animals (most notably mice and rats) shows a near doubling of life span from a very limited calorific intake. Support for the theory has been bolstered by several new studies linking lower basal metabolic rate to increased life expectancy.[113][114][115] That is the key to why animals like giant tortoises can live so long.[116] Studies of humans with life spans of at least 100 have shown a link to decreased thyroid activity, resulting in their lowered metabolic rate.

In a broad survey of zoo animals, no relationship was found between investment of the animal in reproduction and its life span.[117]

Calculation



A survival tree to explain the calculations of life-expectancy. Red numbers indicate chance of survival at a specific age, and blue ones indicate age-specific death rates.

The starting point for calculating life expectancy is the age-specific death rates of the population members. If a large amount of data is available, a statistical population can be created that allow the age-specific death rates to be simply taken as the mortality rates actually experienced at each age (the number of deaths divided by the number of years "exposed to risk" in each data cell). However, it is customary to apply smoothing to iron out, as much as possible, the random statistical fluctuations from one year of age to the next. In the past, a very simple model used for this purpose was the Gompertz function, but more sophisticated methods are now used.[118]

These are the most common methods now used for that purpose:

- to fit a mathematical formula, such as an extension of the Gompertz function, to the data.
- for relatively small amounts of data, to look at an established mortality table that was previously derived for a larger population and make a simple adjustment to it (as multiply by a constant factor) to fit the data.
- with a large number of data, one looks at the mortality rates actually experienced at each age, and applies smoothing (as by cubic splines).

While the data required are easily identified in the case of humans, the computation of life expectancy of industrial products and wild animals involves more indirect techniques. The life expectancy and demography of wild animals are often estimated by capturing, marking, and recapturing them.[119] The life of a product, more often termed shelf life, is also computed using similar methods. In the case of long-lived components, such as those used in critical applications: in aircraft, methods like accelerated aging are used to model the life expectancy of a component.[7]

The age-specific death rates are calculated separately for separate groups of data that are believed to have different mortality rates (such as males and females, and perhaps smokers and non-smokers if data are available separately for those groups) and are then used to calculate a life table from which one can calculate the probability of surviving to each age. In actuarial notation, the probability of surviving from age x to age $x+n$ is denoted ${}_np_x$ and the probability of dying during age x (between ages x and $x+1$) is denoted q_x. For example, if 10% of a group of people alive at their 90th birthday die before their 91st birthday, the age-specific death probability at 90 would be 10%. That is a probability, not a mortality rate.

The expected future lifetime of a life age x in whole years (the *curtate expected lifetime* of *(x)*) is denoted by the symbol e_x.[a] It is the conditional expected future lifetime (in whole years), assuming survival to age x. If $K(x)$ denotes the curtate future lifetime at x,

$$e_x = \operatorname{E}[K(x)] = \sum_{k=0}^{\infty} k \, \Pr(K(x)=k) = \sum_{k=0}^{\infty} k \ {}_kp_x \ q_{x+k}.$$

Substituting ${}_kp_x \, q_{x+k} = {}_kp_x - {}_{k+1}p_x$ in the sum and simplifying gives the equivalent formula:[120] $e_x = \sum_{k=1}^{\infty} {}_kp_x$. If the assumption is made that on average, people live a half year in the year of death, the complete expectation of future lifetime at age x is $e_x + 1/2$.

Life expectancy is by definition an arithmetic mean. It can also be calculated by integrating the survival curve from 0 to positive infinity (or equivalently to the maximum lifespan, sometimes called 'omega'). For an extinct or completed cohort (all people born in year 1850, for example), it can of course simply be calculated by averaging the ages at death.

For cohorts with some survivors, it is estimated by using mortality experience in recent years. The estimates are called period cohort life expectancies.

It is important to note that the statistic is usually based on past mortality experience and assumes that the same age-specific mortality rates will continue into the future. Thus, such life expectancy figures need to be adjusted for temporal trends before calculating how long a currently living individual of a particular age is expected to live. Period life expectancy remains a commonly used statistic to summarize the current health status of a population.

However, for some purposes, such as pensions calculations, it is usual to adjust the life table used by assuming that age-specific death rates will continue to decrease over the years, as they have usually done in the past. That is often done by simply extrapolating past trends; but some models exist to account for the evolution of mortality like the Lee–Carter model.[121]

As discussed above, on an individual basis, a number of factors correlate with a longer life. Factors that are associated with variations in life expectancy include family history, marital status, economic status, physique, exercise, diet, drug use including smoking and alcohol consumption, disposition, education, environment, sleep, climate, and health care.[9]

Healthy life expectancy

In order to assess the quality of these additional years of life, 'healthy life expectancy' has been calculated for the last 30 years. Since 2001, the World Health Organization has published statistics called Healthy life expectancy (HALE), defined as the average number of years that a person can expect to live in "full health" excluding the years lived in less than full health due to disease and/or injury.[122] Since 2004, Eurostat publishes annual statistics called Healthy Life Years (HLY) based on reported activity limitations. The United States uses similar indicators in the framework of the national health promotion and disease prevention plan "Healthy People 2010". More and more countries are using health expectancy indicators to monitor the health of their population.

The long-standing quest for longer life led in the 2010s to a more promising focus on increasing HALE, also known as a person's "healthspan". Besides the benefits of keeping people healthier longer, a goal is to reduce health-care expenses on the many diseases associated with cellular senescence. Approaches being explored include fasting, exercise, and senolytic drugs.[123]

Forecasting

Forecasting life expectancy and mortality forms an important subdivision of demography. Future trends in life expectancy have huge implications for old-age support programs like U.S. Social Security and pension since the cash flow in these systems depends on the number of recipients who are still living (along with the rate of return on the investments or the tax rate in pay-as-you-go systems). With longer life expectancies, the systems see increased cash outflow; if the systems underestimate increases in life-expectancies, they will be unprepared for the large payments that will occur, as humans live longer and longer.

Life expectancy forecasting is usually based on two different approaches:

- Forecasting the life expectancy directly, generally using ARIMA or other time series extrapolation procedures: that has the advantage of simplicity, but it cannot account for changes in mortality at specific ages, and the forecast number cannot be used to derive other life table results. Analyses and forecasts using this approach can be done with any common statistical/mathematical software package, like EViews, R, SAS, Stata, Matlab, or SPSS.
- Forecasting age specific death rates and computing the life expectancy from the results with life table methods: that is usually more complex than simply

forecasting life expectancy because the analyst must deal with correlated age-specific mortality rates, but it seems to be more robust than simple one-dimensional time series approaches. It also yields a set of age specific-rates that may be used to derive other measures, such as survival curves or life expectancies at different ages. The most important approach within this group is the Lee-Carter model,[124] which uses the singular value decomposition on a set of transformed age-specific mortality rates to reduce their dimensionality to a single time series, forecasts that time series and then recovers a full set of age-specific mortality rates from that forecasted value. Software includes Professor Rob J. Hyndman's R package called `demography` and UC Berkeley's LCFIT system .

Policy uses

Life expectancy is one of the factors in measuring the Human Development Index (HDI) of each nation along with adult literacy, education, and standard of living.[125]

Life expectancy is also used in describing the physical quality of life of an area or, for an individual when the value of a life settlement is determined a life insurance policy sold for a cash asset.

Disparities in life expectancy are often cited as demonstrating the need for better medical care or increased social support. A strongly associated indirect measure is income inequality. For the top 21 industrialized countries, if each person is counted equally, life expectancy is lower in more unequal countries (r = −0.907).[126] There is a similar relationship among states in the US (r = −0.620).[127]

Life expectancy vs. maximum

life span

Life expectancy is commonly confused with the average age an adult could expect to live. This confusion may create the expectation that an adult would be unlikely to exceed an average life expectancy, even though, with all statistical probability, an adult, who has already avoided many statistical causes of adolescent mortality, should be expected to outlive the average life expectancy calculated from birth.[128] One must compare life expectancy of the period after childhood, to estimate the life expectancy of an adult.[128] Life expectancy can change dramatically after childhood, even in preindustrial times as is demonstrated by the Roman Life Expectancy table, which estimates life expectancy to be 25 years *at birth*, but 53 years upon reaching age 25.[129] Studies like Plymouth Plantation; "Dead at Forty" and Life Expectancy by Age, 1850–2004 similarly show a dramatic increase in life expectancy once adulthood was reached.[130][131]

Life expectancy differs from maximum life span. Life expectancy is an average for all people in the population — including those who die shortly after birth, those who die in early adulthood (e.g. childbirth, war), and those who live unimpeded until old age. Maximum lifespan is an individual-specific concept — maximum lifespan is therefore an upper bound rather than an average.[128] Science author Christopher Wanjek said "has the human race increased its life span? Not at all. This is one of the biggest misconceptions about old age." The maximum life span, or oldest age a human can live, may be constant.[128] Further, there are many examples of people living significantly longer than the average life expectancy of their time period, such as Socrates, Saint Anthony, Michelangelo, and Benjamin Franklin.[128]

However, anthropologist John D. Hawks criticizes the popular conflation of life span (life expectancy) and maximum life span when popular science writers falsely imply that the average adult human does not live longer than their ancestors. He writes, "[a]ge-specific mortality rates have declined across the adult lifespan. A smaller fraction of adults die at 20, at 30, at 40, at 50, and so on across the lifespan. As a result, we live longer on average... In every way we can measure, human lifespans are longer today than in the immediate past, and longer today than they were 2000 years ago... age-specific mortality rates in adults really have reduced substantially."[132]

See also

- Biodemography
- Calorie restriction
- Demography
- Depreciation
- DNA damage theory of aging
- Glasgow effect
- Healthcare inequality
- Indefinite lifespan
- Life table
- Lindy effect

- List of countries by life expectancy
- List of countries by past life expectancy
- List of longest-living organisms
- Maximum life span
- Medieval demography
- Mitohormesis
- Mortality rate
- Population pyramid
- Senescence

Increasing life expectancy

- Strategies for Engineered Negligible Senescence (SENS)
- John Sperling

- Life extension
- Longevity
- Rejuvenation
- Public health
- Infant mortality

Notes

a. ^ ^ In standard actuarial notation, e_x refers to the expected future lifetime of *(x)* in whole years, while $\mathring{e}_x$ (with a ring above the *e*) denotes the complete expected future lifetime of *(x)*, including the fraction.

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External links

Wikimedia Commons has media related to ***Life expectancy***.

- Charts for all countries
- Our World In Data – Life Expectancy — Visualizations of how life expectancy around the world has changed

historically (by Max Roser). Includes life expectancy for different age groups. Charts for all countries, world maps, and links to more data sources.

- Global Agewatch has the latest internationally comparable statistics on life expectancy from 195 countries.
- Rank Order—Life expectancy at birth from the CIA's World Factbook.
- CDC year-by-year life expectancy figures for USA from the USA Centers for Disease Controls and Prevention, National Center for Health Statistics.
- Life expectancy in Roman times from the University of Texas.

- Animal lifespans: Animal Lifespans from Tesarta Online (Internet Archive); The Life Span of Animals from Dr Bob's All Creatures Site.