Atlas of Science
another view on science
https://atlasofscience.org

Historical stability of the human aging rate and its decline in our time

Using age-related mortality data for 40 countries, it is shown that the rate of aging does not change significantly over history and is almost the same for different countries from the mid-18th to the mid-20th century. However, since the mid-20th century for the first time in history, slowing of the rate of aging in all parameters, including maximum life span, which is apparently associated with pronounced success in the economy, health and social care, has been noted.

The duration of life and the rate of aging of a person are stable species (physiological) constants, the possibility of changing which is of considerable scientific and practical interest.

For many specialists, analysis of age-related mortality has been the main method of studying aging since the time of Gompertz's studies (1825). Age-related mortality was studied in 40 countries from 1750 to 2014 using data from the Human Mortality Database (http://www. mortality.org). Graphs of changes in the overall age-specific mortality rate (m) and its increments ($d(m)$) for neighboring ages were plotted on a logarithmic scale for the ages 1–110 years with ten-year intervals in history, and then the indices of the Gompertz–Makeeham formula: $m = A + R0 \exp(k\,t)$, where A is a constant, an indicator of external influences on mortality; $R0$ and k are the coefficients to reflect the biological nature of mortality, aging itself: $R0$ is the initial level of population aging and k is the rate of change of aging. Index $d(m)$ is the increment in the intensity of mortality per year, which excludes the constant A; i.e., it also reflects the actual aging rate.

The superposition of several curves reflecting the actual aging rate shows that it is practically the same for different countries as it is for the change in the indicator m-A and for an increase in the aging rate $d(m)$ (Fig. 1).

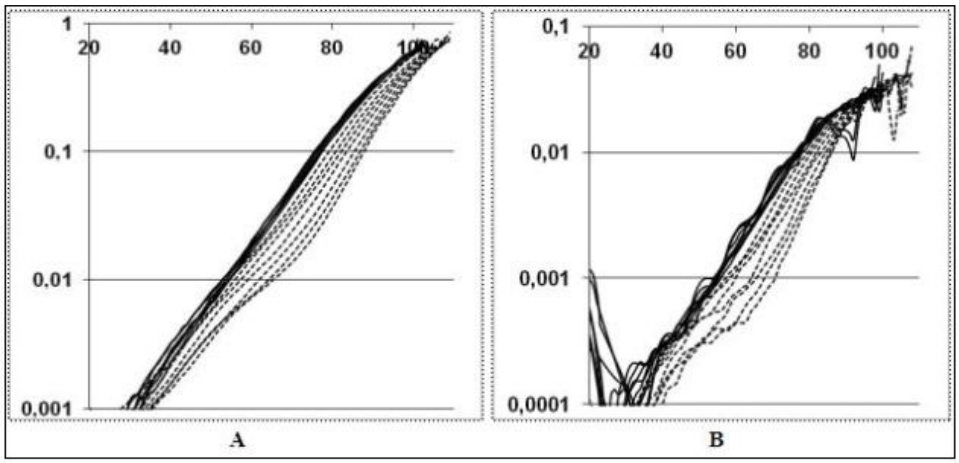

Fig. 1. The rate of aging for the one country in history, France, 1850-2010. On the axis of the ordinate – the intensity of mortality, smoothed by 3 points (semi-logarithmic scale). Along the axis of the abscissa – the age of the survivors, years. A – mortality without background component: m-A, B – increment of mortality intensity: dm. The charts after 1950 are marked with a dashed line.

The aging rate is the same for one country in history up to the middle of the 20th century. However, for the turn of the 20th–21st centuries, there is a sharp decrease in the curves of the aging rate for the ages 55–75 years. For the 12 countries for which data are available since 1900, the decrease in $m - A$ for 65-year-olds over the period of 100 years to 2000 averaged at 2.79 times (from 0.0313 ± 0.0070 to 0.0112 ± 0.0019; $P < 0.001$); similarly for the parameter $d(m)$, it was, on average, 2.81 times (from 0.00279 ± 0.00052 to 0.000990 ± 0.000020; $P < 0.001$). The maximum life span as the age of extinction of the standard cohort, reflecting the rate of aging, also increases evenly (for example, for France, from 105–106 years in 1840–1940 to 114 in 2010). Since 1950 the component k in the Gompertz–Makeem formula, reflecting the exponentially increasing mortality rate with age, is taken as the main characteristic of the aging rate (for 12 countries from 0.177 ± 0.0056 for 1810–1940 up to 0.0833 ± 0.0064 for 1950–2010, $P < 0.001$). A correlation of the component k with the current year (France, 1810–1940) is absent ($r = –0.079$), while since 1950 the correlation has become highly significant ($r = –0.941$).

The influence of external conditions on the aging rate is quite likely. We also proposed a concept of aging that brings pathological changes in natural aging and age-related diseases closer together (Krut'ko, Dontsov et al., 2018); changes in overall vitality during pathological processes are equivalent to the effect on biological aging. In this case, the age-related diseases prevention and a high level of medical and social assistance will affect the apparent rate of aging. The high medical, social, and economic improvements in the quality of life, medical examination, disease prevention, and promotion of a healthy lifestyle, which have been observed in history since the mid-20th century, are probably the reasons that have reduced the rate of human aging.

The effect of the decrease in the rate of human aging since the mid-20th century is the most important phenomenon, which is significant both theoretically and practically in the conditions of the constantly increasing proportion of older ages (aging of the population) and an increase in the retirement age.

Dontsov V.I.
Institute for Systems Analysis Federal Research Center "Computer Science and Control" of Russian Academy of Sciences, Moscow, Russia

Publication

Decrease in Human Aging Rate Since the Middle of the 20th Century
V I Dontsov, V N Krut'ko, O V Mitrohin
Dokl Biol Sci. 2020 Mar