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Epidemics and forecasts of life expectancy

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Dear Editor,

In 1997, Vaupel [1] wrote a rather optimistic paper entitled “The average French baby may live 95 or 100 years”. While the author stressed that “environmental collapse, nuclear devastation, etc.” may nevertheless lead the 1996 birth cohort to “short, miserable lives”, he favoured the hypothesis that “if health, economic and social progress accelerate, then there is a chance that most of the members of this cohort will survive into the 22nd century”. In 2002, Oeppen and Vaupel [2] wrote that “a reasonable scenario would be that... record life expectancy will reach 100 in about six decades” and, in 2009, Christensen et al. [3] published a table reporting the hypothesis of a 107 years median longevity for the 2007 Japanese birth cohort, and thus probably more for women, which is very close to the maximal observed lifespan. However, demographers are usually concerned with period life expectancy at birth (e_0), which is the theoretical life expectancy reached a given year by a population if all age classes of this population were subjected to the mortality conditions of this year. As emphasised by Luy et al. [4], e_0 “reflects the most current death rates cross-sectionally across all ages. This is why (e_0) is of higher relevance for most practical purposes and more frequently used than” cohort life expectancy: this letter focuses on e_0 .

Regarding e_0 , Vaupel et al. [5] published recently a less enthusiastic paper where the authors enumerated the “developments that would slow or even reverse the rise of life expectancy” and particularly that “it might not be possible to reduce mortality after age 100”. This article came after that of Gavrilov et al. [6] reporting that while mortality rates of US men and women younger than 100 years of age are decreasing for decades, those of centenarians remain constant, as also observed for Swedish and Danish centenarians [7]. Obviously, if the mortality rates of centenarians do not decrease, the maximal lifespan can increase only because a higher number of centenarians. If the mortality rate above 100 years of age is 50%, one centenarian among 1,000 is expected to reach 110 years of age, and one among 100,000 to reach 116 years of age. In such conditions, the best one can expect, if we discard the transhumanist hypotheses that major scientific breakthroughs will arrive soon [8], is that more elderly people will live close to 100 but that e_0 will not reach 100.

In France, mortality rates at young ages are now very low and the e_0 changes, particularly of women, are only linked to variations of mortality rates above 65 years of age (Table 1 in [9]). There is now a e_0 stalling in France and e_0 has even decreased in recent years for women (2003 heatwave, 2012 and 2015 flus) and men (2015). Le Bourg [9] hypothesised “that in coming years, life expectancy of French women (and one day of men?) will only very slightly increase and will show oscillations because of increased mortality the years of severe influenza, heatwave and other events threatening the life of frail oldest people”. Such an event occurred in 2020 because of the Covid-19

epidemic (Fig. 1).

Since the complete eradication of smallpox and the near eradication of tuberculosis, developed countries have become accustomed to very low mortality from infection, to the point that some people erroneously think that vaccines are more dangerous than the disease they protect against. However, recent years have shown that the time of epidemics is not over (AIDS, SARS, H5N1, H1N1, Covid-19...), even if they do not all have the same lethality. Covid-19 has a low overall lethality and spares the young for the most part, but lethality strongly increases in the elderly [10]. New deadly epidemics cannot be excluded in a globalised world, because of goods and people circulation, allowing viruses to leave their reservoir species to infect humans. It is thus necessary to forecast their possible effects on e_0 .

A first hypothesis is that, in a demographic situation with a large number of very old people and a stagnation or a small increase of e_0 , an epidemic targeting the most fragile people, usually elderly ones, could cause an e_0 drop before a rebound the following year. This rebound is due to the fact that people who might have died the following year are already dead, the so-called harvesting effect, which leads to a sharp and transient increase in e_0 , as in France in 2004 after the 2003 heatwave [11]. We could thus observe e_0 oscillations with each new epidemic, e_0 decreasing during the year of epidemic and increasing the next year. On the whole, e_0 would remain the same or slightly increase, and e_0 would be punctuated by oscillations each time an epidemic occurs [9].

A second hypothesis is that an e_0 decrease could be observed during several years if the epidemic persists before an e_0 rebound when the outbreak is over. This could be the case with the Covid-19 in 2020, 2021, and maybe later.

These two hypotheses are rather optimistic, as they do not envisage an epidemic affecting young people, such as AIDS or the 1918 Spanish flu. In such a case, the observed effect would be more similar to the 9-year e_0 decline observed for women in France in 1918 (1917: 52.0 years, 1918: 43.3 years, 1919: 50.3 years) than to the 6-month loss in 2020. Figure 2 summarises the three hypotheses: e_0 oscillations, lasting effect of a long epidemic, or an epidemic similar to the Spanish flu.

Of course, one could hypothesise that, thanks to the knowledge of the Covid-19, in coming years we will manage any viral epidemic and oscillations of e_0 will not be observed, but it seems pretty clear that we are currently unable to manage outbreaks. In the meantime, forecasts of lifespan should incorporate new hypotheses taking into account not only the e_0 decrease linked to the current Covid-19, but also the hypothesis that new outbreaks could occur. Current forecasts (see [5] for a review) usually extrapolate past trends and various methods provide different results, for instance for women in 2070 (Table 2 in [5]), but all methods show a regular e_0 increase. However,

it could be sensible to incorporate the hypothesis of new outbreaks, the lethality possibly depending on the age of people, which could make e_0 either to stall or to decrease from time to time. Indeed, we are used to a continuous e_0 increase, but recent years have shown that e_0 can stall or even decrease. Stalling and decrease of e_0 were observed in the Soviet Union in the 1960s and in Russia in the 1990s [12], in the USA because of “deaths of despair” in rather young people in recent years (e.g. [13]), in France because of heatwave and influenza after 2000 (Fig. 1), and in many countries in 2020 (e.g. in the USA [14]). The Covid-19 shows that the e_0 decrease is not only observed in one or a few countries, and that wealthy nations are not spared. In such conditions, future forecasts of lifespans ignoring the hypothesis of possible new outbreaks would probably miss a major hypothesis: e_0 can also decrease.

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Figure 1. Life expectancy at birth (e_0) of French men and women, from 1993 to 2020. The years of e_0 decrease are shown. The 2018 to 2020 data (including Mayotte) are provisional [15].

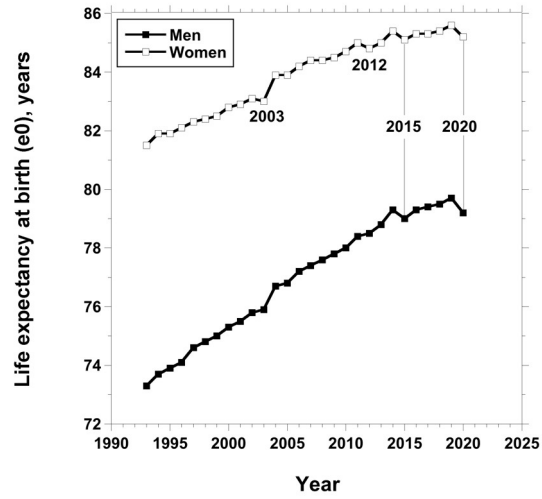
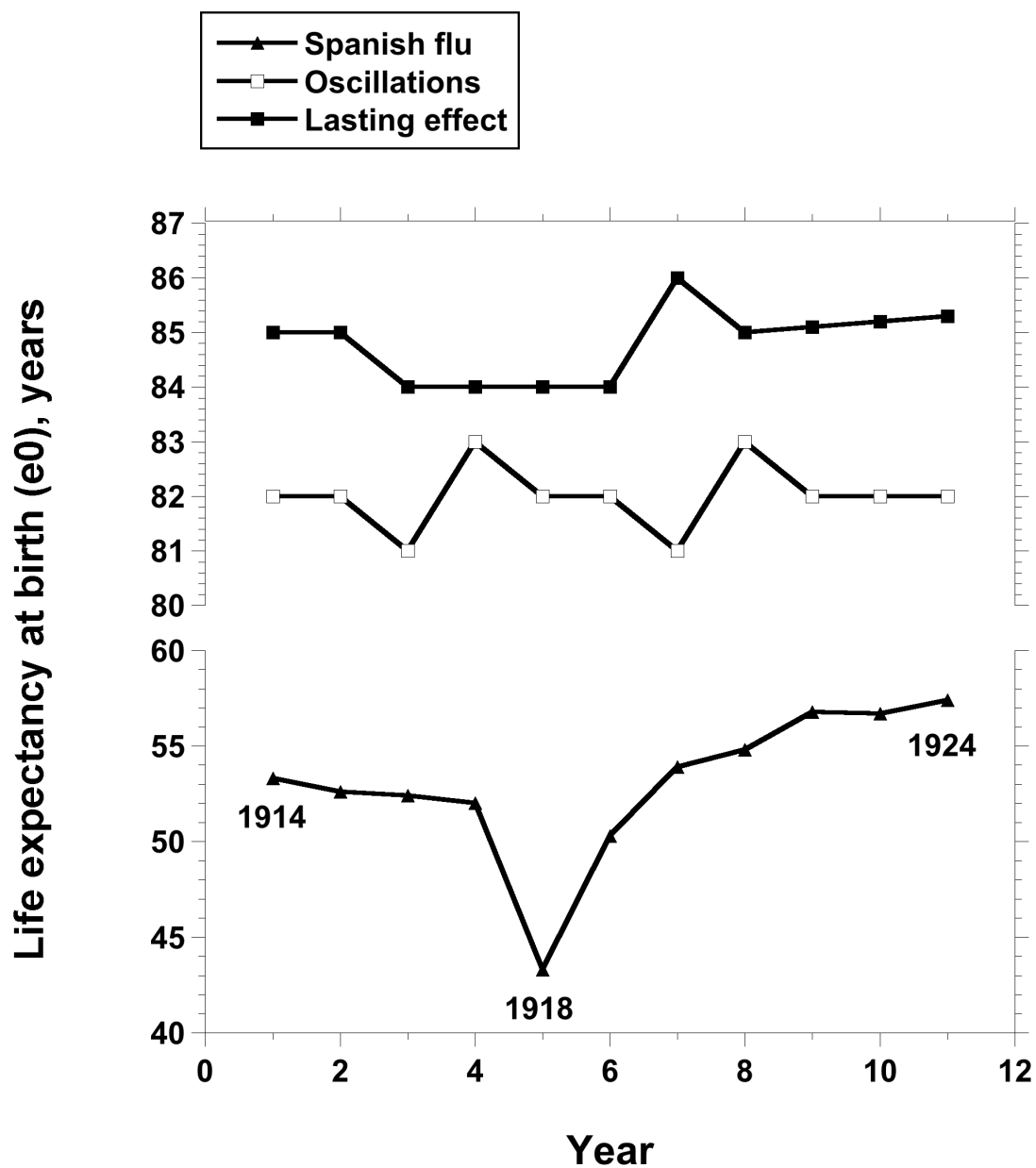


Figure 2. Possible changes of life expectancy at birth (e_0) in the event of epidemic. Values of e_0 are fictitious in the Oscillations and Lasting effect scenarios. The figure shows an absence of e_0 increase in the long-term (Oscillations) but also a slight increase (Lasting effect). For Spanish flu, e_0 values of French women from 1914 to 1924 are shown.



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