# The uncertainty of the future development of life expectancy

**Life expectancy in most developed countries rose markedly and steadily over recent decades. Currently, however, we are observing a weakening of this increase – and in some countries even a decline. '*Life Expectancy – Is the Party Over?*' asked BBC News as early as 2015. At the same time, Biogerontology (the science of the physiology and biology of aging) has been making remarkable progress. According to leading researchers, fundamental processes underlying human aging are now understood and, in principle, druggable. So, the answer to the BBC question might very well be: '*No, the Party hasn't even started!*'**

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### THE PARTY IS OVER

There are numerous arguments suggesting that life expectancy will increase at a significantly slower pace (or possibly decrease) in the future. Many arguments were presented in detail in a talk by one of the authors at the 2023 Annual Meeting of the German Society of Actuaries[1]. Here, we highlight just one example: seniors typically suffer from multiple diseases simultaneously. 'Normal medical progress' develops and improves cures for individual diseases. However, if one cures the disease that would have killed an 85-year-old next year, they often have several other diseases that might kill them one year later. This appears to be a structural barrier for a significant reduction in mortality among seniors, without which a further significant increase in life expectancy is practically impossible as the gain in life expectancy from curing a specific disease diminishes as population ages. In fact, this is a key driver for a famous result by Olshansky et al.[2] who essentially claim that the 'speed of medical progress' would need to rise ever faster to create a further steady increase in life expectancy. The assumptions of their model would, however, no longer hold if the fundamental processes of aging are modified.

### THE PARTY HASN'T EVEN STARTED

The end of the party thus seems inevitable, unless aging itself can be slowed. However, precisely this has come within reach. Numerous promising approaches were presented in the aforementioned talk; here we briefly outline three examples:

1) A study with diabetics found that those treated with the drug Metformin not only exhibited higher life expectancy than patients receiving other medications, but even higher life expectancy than non-diabetics[3]. Moreover, many age-related diseases occur later and with lower incidence. Whether Metformin also slows aging in non-diabetics is currently being investigated in a study called TAME (Targeting Ageing with Metformin)[4].

2) The human body contains many 'communication channels' through which signals can be sent to cells via certain molecules and proteins. For example, when the mTOR signaling pathway is inhibited, the body perceives a state of nutrient scarcity, and a process called autophagy is initiated, during which defective proteins and damaged cellular components are being 'eaten up'. This self-cleaning process can be triggered by fasting or intermittent fasting. In the future, drugs might inhibit the pathway without fasting. The most promising candidate is a drug called Rapamycin. A very recent study[5] shows that a combination of Rapamycin and a drug called Trametinib substantially increases both life expectancy and maximum possible lifespan in mice.

3) Senolytics are drugs that eliminate so-called senescent cells. These are cells that can no longer divide but did not die. Their accumulation is considered a major cause of age-related diseases. The elimination of senescent cells reportedly has a massive impact on life expectancy in mice. A large number of senolytics are currently in clinical studies with humans.

### IMPLICATIONS FOR ACTUARIES AND RECENT RESEARCH

Actuaries deal with modeling, measuring, and managing risks, typically relying on analyses of historical data. The arguments presented above suggest that there is currently uncertainty which cannot be inferred from historical data. Therefore, a deeper, interdisciplinary understanding of the risks is required to decide whether expert judgement should also be incorporated into modeling (alongside insights from historical data).

> **DEEPER INTERDISCIPLINARY UNDERSTANDING OF RISKS IS REQUIRED**

One approach might be to derive selected deterministic scenarios, for example, an optimistic scenario (Drug A will be available to the general population in 10 years and Drug B in 15 years). Based on expert assessments of their potential effects, a corresponding trajectory of life expectancy could be derived for this optimistic scenario (and analogously, if applicable, for a very optimistic, pessimistic, or a very pessimistic scenario). These scenarios could then serve as inputs for deterministic scenario analyses.

Even more compelling would be the integration of such scenarios into stochastic mortality models. This becomes particularly relevant whenever experts come up with a plausible (albeit unlikely) scenario that is considered 'virtually impossible' by a stochastic mortality model that has been calibrated to historical data only. In a recent, interdisciplinary article with a leading biogerontologist, we have proposed a methodology for calibrating stochastic mortality models such that scenarios that are 'plausible albeit unlikely' from a biological perspective occur in the model with a certain probability[6].

In another recent study, we examine how the structural relationship between the speed of medical progress and the speed of increase in life expectancy mentioned above would change if a new type of medical progress emerges, i.e., slowing down aging. We can show that under assumptions that are consistent with a slowdown of aging, a constant speed of medical progress would be sufficient to sustain a long-term linear increase in life expectancy[7]. This is structurally completely different from the exponential speed of medical progress required under the current type of medical progress.

### CONCLUSION

The uncertainty regarding the future development of human life expectancy is currently extremely high in both directions. A better understanding of this uncertainty requires an interdisciplinary approach. Translating the resulting insights into scenarios, probabilities, and ultimately into models to obtain enhanced risk assessment calls for calibration approaches for mortality models that explicitly consider available expert judgement.

Can the necessary scenarios be estimated precisely? Of course not. Would such a model nevertheless be 'better' than a model calibrated solely to historical data? We claim that the answer is 'yes', whenever future developments emerge on the horizon that are not reflected in historical data but can be reasonably assessed by experts in their respective fields. ■

1 – www.ifa-ulm.de/Lebenserwartung.pdf; Slides of an English version of the talk are available at www.ifa-ulm.de/uncertainty-le.pdf

2 – Olshansky, S. J., Carnes B. A., and Cassel C. (1990). In search of Methuselah: estimating the upper limits to human longevity, *Science* 250(4981), 634–640.

3 – Bannister, C. A. et al. (2014). Can people with type 2 diabetes live longer than those without? A comparison of mortality in people initiated with metformin or sulphonylurea monotherapy and matched, non-diabetic controls. *Diabetes, Obesity and Metabolism*, 16(11), 1165-1173.

4 – cf. https://www.afar.org/tame-trial.

5 – Gkioni, L. et al. (2025). The geroprotectors trametinib and rapamycin combine additively to extend mouse healthspan and lifespan. *Nature Aging*, 5(7), 1249-1265.

6 – Faragher R.G.A., Freimann, A., and Ruß, J. (2026). Scanning the horizon: integrating expert knowledge into the calibration of stochastic mortality models. *Insurance: Mathematics and Economics* (127)

7 – Faragher, R.G.A., Freimann, A., Huber, T., Partridge, L., and Ruß, J. (2026). *Finding Methuselah: Linear increases in life expectancy do not require ever faster declines in mortality*. Working Paper.