WDA FORUM World Demographic & Ageing Forum

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Global Demographic Change

On Longevity

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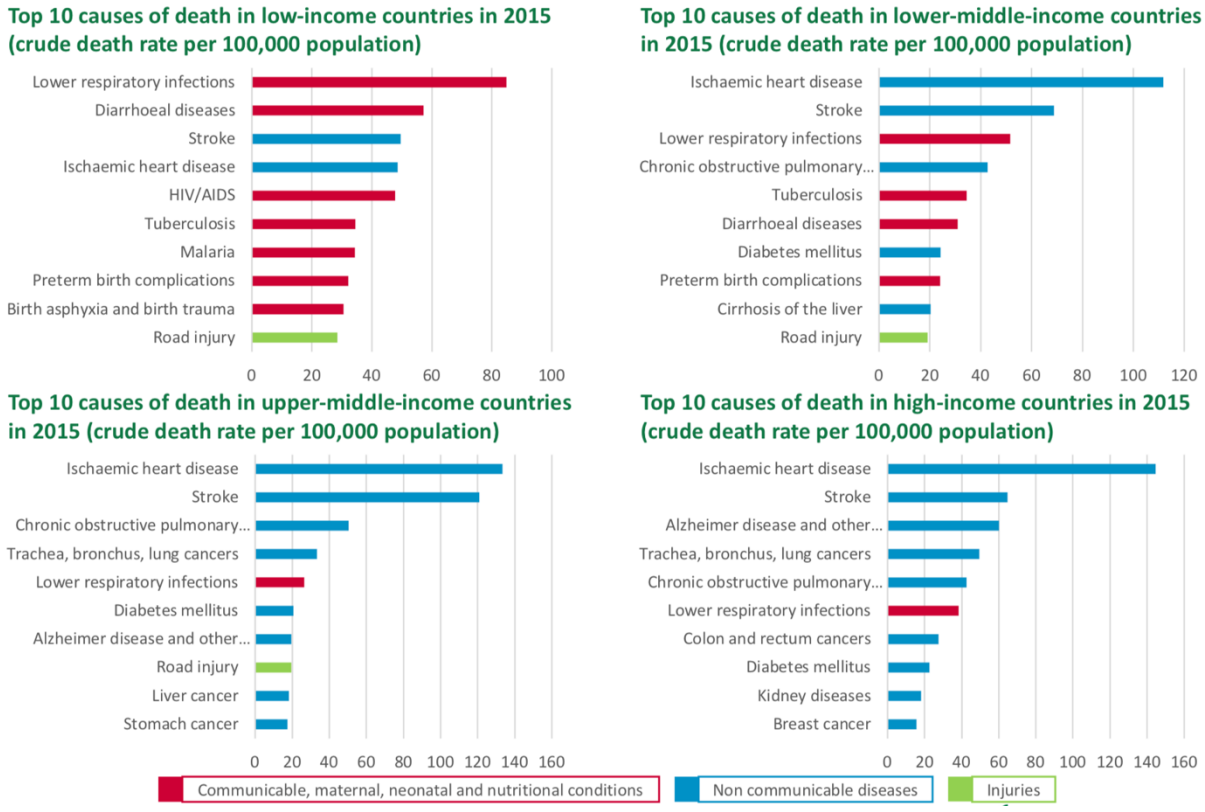
1. Introduction

This briefing paper examines the leading causes of death today in countries across the globe, with a focus on high-income countries, the diversity and ongoing dynamics of mortality, and the arrival of a series of new players providing alternative solutions and treatments to contribute to a longer and healthier life. Based on this, a number of scenarios forecasting life expectancy with different degrees of probability are presented.

2. Leading causes of death in 2015

Using the World Bank classification of countries in terms of income, the World Health Organization (WHO) looks at the leading causes of death in low-income countries (gross national income (GNI) of US$1,025 or less), lower-middle-income countries (GNI between US$1,026 and US$4,035), upper-middle-income countries (GNI between US$4,036 and US$12,475) and high-income countries (GNI above US$12,476) in 2015. The WHO classifies these causes of death in three categories: communicable, maternal, neonatal and nutritional conditions (Group I); non-communicable diseases (Group II); and injuries (Group III).



As illustrated on the graphs above, the mortality patterns look very different whether a country is in the low-income cluster or in the high-income cluster. The most striking difference between these brackets is the importance of communicable diseases (Group I), which represents 52% of all deaths for low-income countries and only 7% for high-income countries. Overall, the richer a country is, the more it is able to reduce or even virtually eliminate deaths from communicable, maternal, neonatal and nutritional conditions, with the exception of lower respiratory infections. The overall result of this transition is: In high income countries the leading causes of death are by far non-communicable diseases.

Having a closer look at the leading causes of death in high-income countries, we notice that the top spots are taken by ischemic heart disease, stroke, Alzheimer disease/ dementia and a variety of cancers such as trachea, bronchus, lung, colon, rectum and breast cancers. Causes and treatments of each of these diseases is beyond the scope of this paper, but one can clearly state that these diseases are age-related diseases to a high extend. In short, today mankind increasingly dies from the consequences of ageing.

3. The science behind ageing

If further increases of longevity are the goal, one needs to understand the science behind ageing. The problem is that, even today, the process of ageing eludes scientists. The WHO explains it as follows: “At the biological level, ageing results from the impact of the accumulation of a wide variety of molecular and cellular damage over time. This leads to a gradual decrease in physical and mental capacity, a growing risk of disease, and ultimately, death”. But what causes these damages? What are the factors affecting ageing? And is there something that can be treated and even cured? This is subject on to ongoing research and ongoing scientific debate.

The numerous mechanisms why humans actually age still puzzle scientists. But the factors impacting ageing are relatively straightforward. They are classified in two principle categories: genetics and environment. The first category, genetics, has mostly to do with the DNA-damage-theory of ageing. People with “good” genes have a higher chance of living longer and most frequently in better conditions. In the past decades, there has been considerable progress – mostly in laboratory settings – to understand what genes might influence the ageing process. Whether one can identify these genes in humans and modify them to delay or even eliminate the process of ageing is subject to ongoing research with unclear outcome.

However, having good or bad genes is not at all the only determinant of ageing. The second main category deals with the environment a person lives in. To give a very simple example, assuming that two twins share the same DNA, how is it possible that they still can show significant differences in terms of their actual life expectancy? In their paper “Human longevity: Genetics or Lifestyle? It takes two to tango”, Giuseppe Passarino, Francesco De Rango, and Alberto Montesanto argue that only 25% of the variation in human longevity is due to genetics and that environmental factors play a very large role. Following a healthy diet, exercising on a regular basis, sleeping enough, not smoking, not getting sunshine for too long, balancing stress, all decrease the chances of getting age-related diseases and thus lead to longer life expectancies. Of course, there are still many questions such as to what extent each of these behaviors affects ageing and what re the best practices to actually live these behaviors. Air pollution is also starting to become an important factor in a third of all deaths from stroke, lung cancer and respiratory diseases. And finally climate change is another phenomenon starting to affect mortality at all ages but particularly older age cohorts.

Today the standard way to deal with age-related diseases is to treat them when they become evident or symptomatic. If a given treatment is successful, the patient gets to live longer, and this process is repeated until the patient dies. This approach has been used for centuries and has been very effective particularly for infectious diseases. But as we age more and more, this method will reach its limits at some time. For how many times and how long can we patch someone cure and rehabilitate? One should always keep in mind: Each intervention increases the chances of further and often unexpected complications. We are now

witnessing a move from reactive/rehabilitative to preventive medicine, which aims at combatting actively the mechanisms of ageing, for instance with healthy lifestyle campaigns and research in genetics.

4. Technology applied to healthcare

We are witnessing an unprecedented information technology shift in all aspects of our life and this affects also healthcare and healthcare provision. New biotech players are challenging existing practices and are trying to come up with innovative solutions backed up by big data and information technology. A few of these trends and how they affect healthcare will be described later in this paper. However, it is important to note that even though these players are new, there is still a strong tendency to work alongside traditional healthcare actors, such as large pharmaceutical companies, hospitals and ambulatory care networks.

The first and most predominant trend is the rise of artificial intelligence (AI) and machine learning. While they seem out of place and far off in certain industries, they are very much on point when it comes to efficient and affordable access to healthcare all across the world. Two business cases may exemplify their importance. First, in terms of disease identification and diagnosis, we have relied in thepast on highly trained medical experts. Recently, they have been supported by advanced instruments such as scanners, X-rays and the likes. But nowadays, this goes even further: A recently developed AI system was found to correctly diagnose skin cancer more accurately than dermatologists. Another important application of AI and machine learning is in drug discovery. Pharmaceutical companies spend an average of 12 years and billions of dollars in research and development to finally launch just a new medicine. It is a fact that companies have only been able to grab the most obvious drugs and do not have the capacity to go much further with our brains alone. Using big data of established players, new players apply AI and machine learning, especially deep learning, to identify and test new drugs, offer potential leads, and draw new connections. Two players are very important in this new field: Google with Deepmind Health and IBM, with Watson for Drug Discovery.

Another trend is the mainstream use of tracking devices and its underlying potential for disease prevention and monitoring. Medical touchpoints have been very limited in the past. People would only go to their generalists or to the hospital once in a while, and only when they had a ”visible or tangible” problem. The weakness of this approach is that it simply aims at reacting to selected urgency situations and is mostly based on limited data. Smartphones, smartwatches and fitness tracking devices are becoming customary all across the world with unprecedented speed. This has profound consequences as they are constantly collecting data. With the consent of patients, medical providers can now make alert warnings much more accurately, inform people who present early signs of a given disease and even recommend tailored healthy behaviors such as diet, exercise and drinking and smoking habits. One category of these new actors is the device industry. But other players such as insurance providers are also entering the scene. An interesting example is Discovery, a South African insurance provider offering lower premiums to policyholders going to the gym on a regular basis and using tracking devices. Another example is from Singapore: AIA Vitality is offering lower premiums to members who purchase healthy food in supermarkets with a special credit card.
Overall, these tracking devices are closely related to artificial intelligence and machine learning as they are feeding data that can then be analyzed to further medical research. They will innovate research in and for healthcare.

5. Forecasting the increase of life expectancy

It is very important for governments and their social security systems to forecast life expectancy scenarios. They have to anticipate and prepare for what is coming and adapt the many actors that will be affected in whatever way. However, forecasting can be a difficult exercise and it is very common for economists and scientists to get it wrong. A new approach is combining a series of scenarios, based on historical data and current understandings of modern healthcare, but excluding the latest technological improvements out of the model. Another attempt is the Washington Longevity scenarios for 2030, focusing on potential technological advancements. Because of many uncertainties this model is highly speculative.

Based on the paper “Future life expectancy in 35 industrialized countries: projections with a Bayesian model ensemble” by Vasilis Kontis, James E Bennett, Colin D Mathers, Guangquan Li, Kyle Foreman, and Prof Majid Ezzati, the first model encompasses 21 different forecasting models with weighted probabilities, to forecast the life expectancy increase between 2010 and 2030 in 35 high-income countries. This probabilistic model is called Bayesian model averaging (BMA) and is increasingly used for weather and climate forecasts. The advantage is that it does not restrict itself to one theoretical model and encompasses a broad range of views. For instance, both the optimistic model predicting a continuous increase in life expectancy at a similar rate as the one witnessed for the past two centuries, and the pessimistic model predicting life expectancy to stall due to obesity and other health hazards, are included.

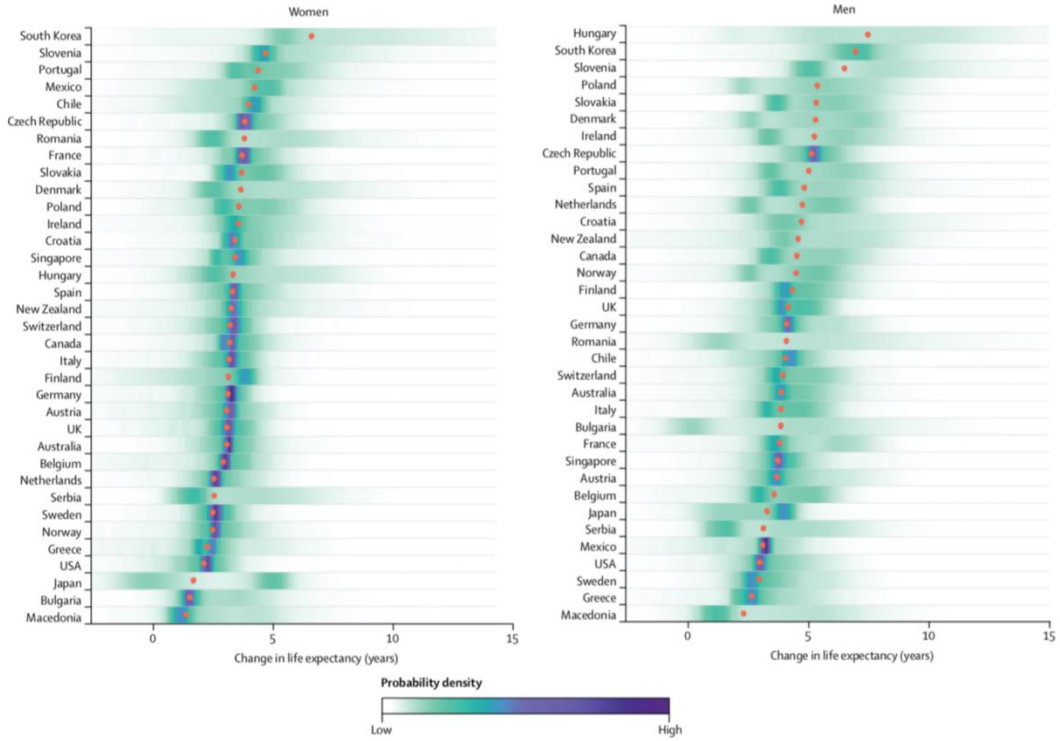


Figure 1: **Posterior distribution of projected change in life expectancy at birth from 2010 to 2030**
Red dots show the posterior medians. Countries are ordered vertically by median projected increase from largest (at the top) to smallest (at the bottom).

As can be seen on this graph, the likelihood that life expectancy continues to increase is very high. The authors even state that there is a 65% chance that life expectancy for women increases in all 35 countries, and an 85% chance for men. South Korea leads in term of gains both for men, with a second place, and women, with the first spot. The life expectancy

at birth for South Korean women in 2030 is expected to be higher than 86.7 years with a 90% probability, and higher than 90 years with a 57% probability, placing South Korea not only as the winner in term of gains, but even in absolute term. Overall, the expected average gain remains below 5 years for women and very close to 5 years for men. The pessimistic forecast for women is still a solid increase of around 2 years, while the positive forecast exceeds the 5-year threshold in most countries, even reaching 10 years in 4 countries. For men, the pessimistic forecast is also an increase of around 2 years, though slightly superior to the one observed for women. The optimistic forecast all exceeds the 5-year threshold and a 10-year increase is possible in more than 10 countries, even though it is very unlikely.

This BMA model represents a good synthesis of most commonly accepted forecast models, but it fails to acknowledge the possible revolution that information technologies could bring. That is where the Washington Longevity scenarios for 2030 come in. It was developed by Future Tense, a group including Arizona State University. They present 4 different scenarios for life expectancy increase focusing on technological aspects. Scenario A, small change, is the one they consider the most likely to happen. It says that these technologies will have very limited effects and, as a result, there will be little change to today's predictions. This first scenario is then very similar to the results shown previously. Scenario B, drooling on their shoes, postulates that these technologies will allow people to live significantly longer, but that we won't increase our healthy life expectancy. In short, we would just spend more time in retirement homes, trying to survive from one operation to the other. The costs for society in this scenario would be very important and we would have to rethink the whole pension system. Scenario C considers the possibility that these technologies, not only increase our life expectancy, but also our healthy life expectancy. In these cases, we would be able to live until 150 years old in healthy conditions. This would obviously change society as we know it, offering people choices they never envisioned before. Scenario D is the most extreme one and the least likely to happen. In this scenario, we would have overcome ageing and would be able to live forever. Even though it is highly improbable, they do not rule it out as they explain that, if the improvement brought by digital technologies increase at a faster rate than we age, we could in theory live forever.

6. Conclusion

For the past two centuries, life expectancy has for the most part continuously increased, with an average increase of around 0.25 years each year in developed countries. Among the many factors that contribute to these increases, the decline of communicable, maternal, neonatal and nutritional diseases played an important role. Today, these diseases are still dominant in low- and lower-middle-income countries. Wealthier countries have managed to overcome many of these diseases and their populations now mostly die of age-related diseases. The process of ageing is the next obstacle that mankind faces in order to improve both its life expectancy, but also and most importantly its healthy life expectancy. While this process is not yet fully understood by scientists, its mysteries are slowly unraveling. Moreover, in the digital age, one can expect new technologies keep pushing our life expectancy, though still uncertain to what extent.

Overall, for numerous reasons life expectancy is very likely to continue to increase all across the globe. The only difference on a country or a regional level will be the speed of this change.

About the WDA Forum

Population trends as well as ageing and generational issues are among the key challenges of the 21st century, but also a source of unique opportunities. With a vision of maintaining and enhancing welfare and prosperityin the future, the WDA Forum aims to address and research these demographic issues and their impact on the social, economic and political environment in the international context. To this end, it has defined five areas of action: work life, retirement plans, financial markets, health and digital ageing. As a think tank, the WDA Forum works closely with the Institute of Insurance Economics at the University of St. Gallen as well as other educational and research institutions including the Harvard T.H. Chan School of Public Health in Boston, Stanford University in California, Population and Ageing Centre at the University of New South Wales in Sydney and the Fudan University in Shanghai. The WDA Forum was established in 2002 and is based in St. Gallen.
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