Getting More **out of Life**

Demographers are astounded at the way human mortality continues to drop. This trend started well over a hundred years ago. What used to be a statistical investigation of death rates has now developed into the science of longevity. This is what **Jutta Gampe** focuses on at the **Max Planck Institute for Demographic Research** in Rostock.

TEXT **BJÖRN SCHWENTKER**

Life expectancy is a tricky thing. The formula may well have been worked out scientifically, but the result shouldn't be taken at face value – at least not if you want to know how long we are actually likely to live.

It's easy to get confused. Here's an example: if one believes the German Federal Bureau of Statistics, the life expectancy of a girl born in 2009 is 82 years and 7 months (77 years and 6 months for a boy). But scientists from the Max Planck Institute for Demographic Research in Rostock have calculated that every baby born in Germany in 2009 has a 50 percent chance of living to be at least 100. How can that be?

"The Bureau's statisticians didn't miscalculate," says Max Planck researcher Jutta Gampe, "nor did the many other statistical offices around the world, or the United Nations, all of which use the same formula for calculating life expectancy." Nevertheless, with lifespan increasing so strongly and constantly, as has been the case for decades, birth-year life expectancy suggests a significantly lower age than the relevant group will actually reach on average.

ONE FORMULA – TWO RESULTS

The problem lies not in the calculation input, but in how it's interpreted. Behind the calculation is an assumption that is often overlooked in public discussion: the calculated figure would be correct only if living conditions were to remain at the level they had reached at the time of the calculation. This means that, if 2009 conditions were to remain unchanged, the 2009 cohort would indeed have a life expectancy of around 80 years.

However, if we consider that conditions are likely to improve just as rapidly in the future as demographers have already observed for the last 150 years, then we arrive at the result proposed by the Max Planck institute, namely that that same cohort has a 50 percent probability of living to at least 100. Unfortunately, it won't be possible to measure the life expectancy actually achieved by today's birth cohort for about 120 years – retrospectively, when the date of death is known for all babies born now. But policymakers and the general public don't want to wait that long to discuss the lifespan of current generations.

Jutta Gampe, a statistician at the Max Planck institute in Rostock, has already shed statistical light on just about every conceivable area of demographic data, and it is her job to investigate how best to describe the population dynamics that are currently popularly

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Jutta Gampe has a professional interest in time. A researcher at the Max Planck Institute for Demographic Research, she is investigating how mortality is changing.

The mortality revolution: Mortality is currently falling fast in almost all countries. In the developed nations of Europe, this process began more than 150 years ago, and continues today. For instance, the mortality risk for a 60-year-old French woman fell by almost one-fifth between 1929 and 2009. But the figure has been falling for every other age group, too. This means that a given mortality risk today is reached much later than in the past. In France, the level of risk for a woman of 60 in 1929 was not reached in 1969 until her 69th birthday, and in 2009, not until she was 78. This enduring decline in mortality also means that aging is constantly being pushed back to a later point in life. Children born today will thus be much fitter in old age than their mothers.

known as "demographic change." As far as aging is concerned, she has a clear answer: a far better gauge of current life expectancy is mortality. Or more precisely: the death rate, or the risk of dying at a given age.

LIFE EXPECTANCY IS RISING BECAUSE MORTALITY IS FALLING

Because these rates are unambiguous whatever the year, be it 1850 or 2012, they unequivocally reveal what aging, so often depicted in negative terms, actually means: that death is on the retreat universally. "Almost everywhere in the world, mortality has been falling for virtually every age group, in many countries for decades, and in developed nations like Germany, even for more than a century," says Gampe. In quite a number of nations, there has been such a sustained and rapid fall in rates that a female retiree of 65 now has the same risk of dying as a 55-year-old did 50 years ago. At the same time, people are staying healthy longer.

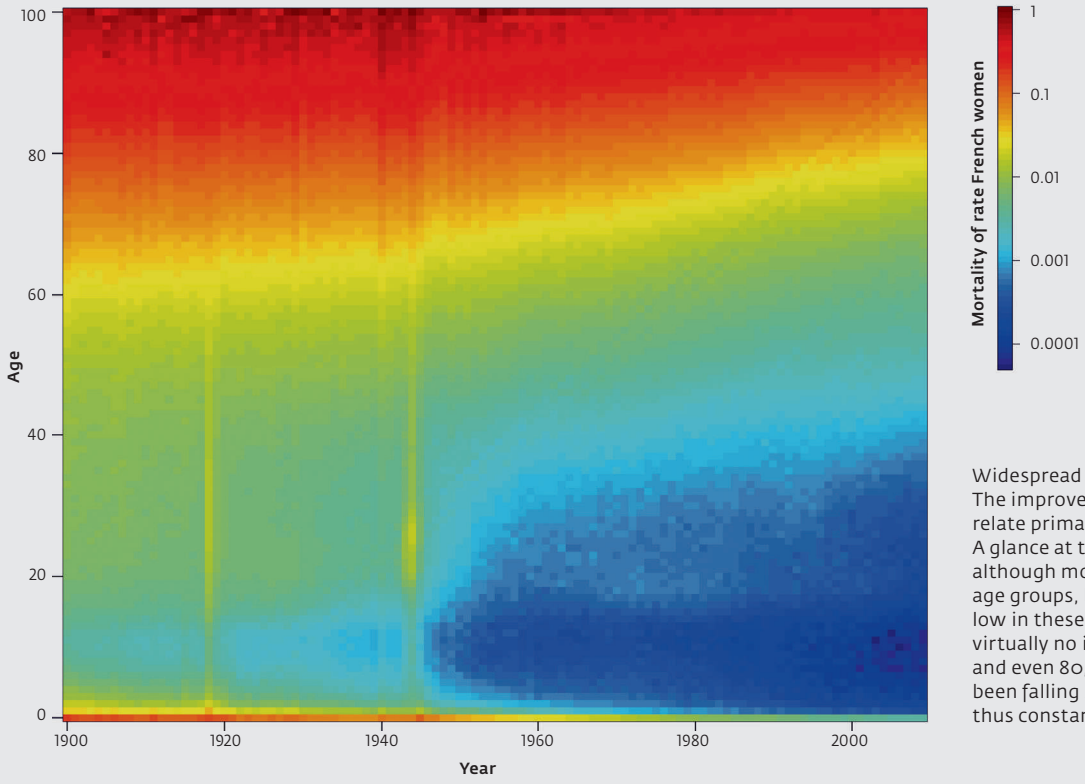
"From the point of view of mortality, 65 is the new 55," says Gampe. She sees mortality's nosedive as one of the greatest achievements of recent human history, and not, for instance, as a problem of "population aging," as is so often concluded in light of ever higher numbers of people reaching the age of 80, 90 or 100. "When mortality constantly declines, life expectancy automatically rises," explains Jutta Gampe.

Lower mortality means that more and more people are surviving longer. Average lifespan is thus soaring as impressively as mortality is falling. "Every increase in life expectancy is the consequence of a very welcome process: the ever lower probability of an early death," says Gampe, rejecting the conventional image of an aging and therefore senile society as just plain wrong.

Mortality rates have been calculated by many generations of researchers. To be able to make these calculations, all that is needed are simple population data: the number of people of a given age and how many of them die in that year of age. The Max Planck institute in Rostock, together with demographers from the university in Berkeley, currently maintain the largest database of such figures, including actual death rates, in the world. The Human Mortality Database contains details from all countries for which reliable data is available – often harking back to the 19th century, and freely available online for researchers and the general public.

For demographers, mortality is more than just a number. The English expression "force of mortality" carries a deeper meaning: mortality is the force that drives us into the arms of death. The history of mortality statistics, however, has since demonstrated one thing above all: just how powerful the human life force is, finding more and more weapons against mortality, such as better living conditions, more and more-nutritious food, continuous medical progress and, in general, a healthier lifestyle.

Photo: iStockphoto; graphic: MPI for Demographic Research



Widespread misunderstanding: The improvements in mortality by no means relate primarily to children and young people. A glance at the past century shows that, although mortality continues to fall for these age groups, by the 1950s, mortality was so low in these age groups that reductions had virtually no impact. At the older ages of 60, 70 and even 80, on the other hand, rates have been falling significantly. Improvements are thus constantly shifting to older age groups.

Graphic: MPI for Demographic Research

"Anyone working with mortality rates is at a clear advantage when it comes to demonstrating the gain in personal lifespan," says Jutta Gampe. The mortality rate indicates how many people of the same age have died, so for instance two deaths among 100 women aged 75. Mortality risk, on the other hand, corresponds to the probability of dying in a particular year of life. In simple terms, mortality rate and mortality risk are the same thing. However, the latter relates to an entire year of life, while the mortality rate takes account of only the time actually lived in a year of life. If one of the two 75-year-olds dies after just a quarter of a year and the other after half a year, the mortality rate is calculated on the basis of 2:98.75, while the mortality risk is calculated on the basis of 2:100. The difference becomes more apparent in old age, when more people from a given cohort die.

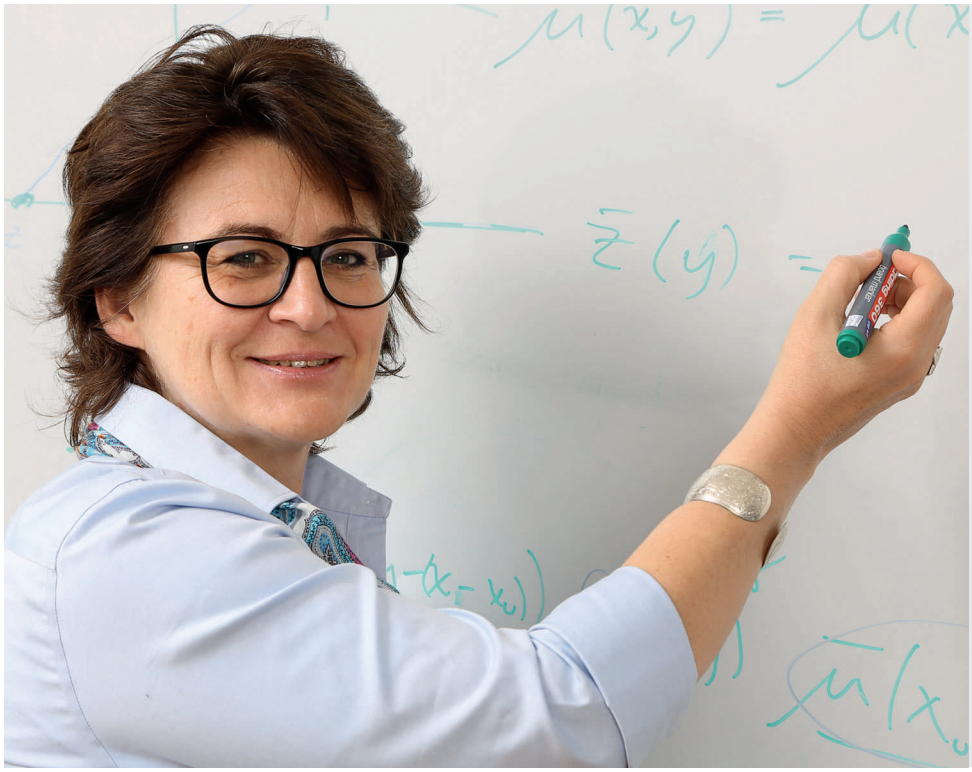
Jutta Gampe uses the example of her own life to work out what the improvement in mortality means for the life span she can expect: she has seen her risk of dying at her current age of 51 halved since she came into the world: from 0.005 in Austria in 1961 to less than 0.0024 today.

At the time of her birth in 1961, an Austrian statistician would have told the proud parents of baby Jutta that their little girl could expect to live nearly 73 years. But now she is 51, with half a century behind her, and has seen the world around her develop at lightning speed.

MEN AND WOMEN ARE DIFFERENT – RIGHT UP TO DEATH

An expert at the German Federal Bureau of Statistics in Wiesbaden would give her, as a woman, a remaining life expectancy of just under 33 years. Added to the 51 years she has already lived, Gampe would thus reach almost 84 – 11 more years than predicted at her birth. However, this still involves the same error of interpretation mentioned earlier: Gampe's life expectancy will remain 84 only if the world stops developing as of today, which is highly unlikely. It is much more likely that the statistician will live to be 90 or older.
If we let go of the rough measure that is life expectancy and take five minutes to become familiar with the significance of mortality risk and the age curves relating to it, we can learn a lot: not only from which year of our life we start to age, but also the pace at which aging then progresses, and by how much the general mortality level will continue to fall over the course of our lifetime. Mortality curves also reveal the death and survival history of entire nations. And they provide evidence that men and women are different – right up to death.

However, anyone who ventures to look at how mortality risk increases over the course of their life needs to be made of stern stuff. After a certain age, the mortality curve goes through the roof. Nevertheless, it is comforting to know that, these days, the risk of death doesn't start to climb sharply until around the age of 80. Until that point,



Calculating a timetable for aging: The risk of dying in a given year is so minute during the first 60 years of life that it isn't even visible on a diagram of normal scale (1). According to this diagram, in western Germany, the risk of mortality for men aged 60 is 0.01, corresponding to a probability of around 1 percent; by age 80, mortality rises to 10 percent. In mathematical terms, the rate rises exponentially, meaning that it increases by the same proportion from one age year to the next, in this case by around 10 percent of the figure for the previous age year. In the first half of one's life, this increase is barely perceptible. But if the low mortality rates are magnified as in diagram (2), then the increase becomes visible here, too. In actual fact, mortality risk doesn't increase exponentially until we reach age 40.

» Thus, in simple terms, from 40 onward, people age at the same rate year for year. «

it just plods along. For a woman in western Germany aged 20 in 2009, it is negligible, at 0.0002.

Although it will have more than tripled by her 40th birthday, to 0.0007, at least it still makes much more sense, statistically, for her to carry on with her plans for living than to plan for her imminent demise. Even at 60, the risk of death is still scarcely worth mentioning: at just under 0.006, it corresponds to a probable mortality of a good half-percent. After that, however, the rate rises sharply: at 80, the probability of meeting with death during that year is as high as 4 percent; at 90 it's around 15 percent; and at 95, almost 27 percent.

Is there a rule behind this meteoric rise? A natural mathematical law of aging? This was a question asked way back in the closing years of the 18th century by a young Londoner, Benjamin Gompertz. As a Jew barred from a university education, he was a self-educated mathematician who worked in a field that is still extremely interested in the correct calculation of mortality: the insurance industry.

Gompertz taught himself the necessary mathematics, sifted through masses of population data relating to humans and animals, and suddenly realized that, although mortality rates are initially very low, and then abruptly become very high, from a certain age they increase year for year by the same percentage. For human adults, the annual rate of increase is around 10 percent for each year of life. In youth, this is of barely any consequence: a tiny risk increased by a tenth is still tiny.

PUBERTAL MALES HAVE AN INCREASED RISK OF MORTALITY

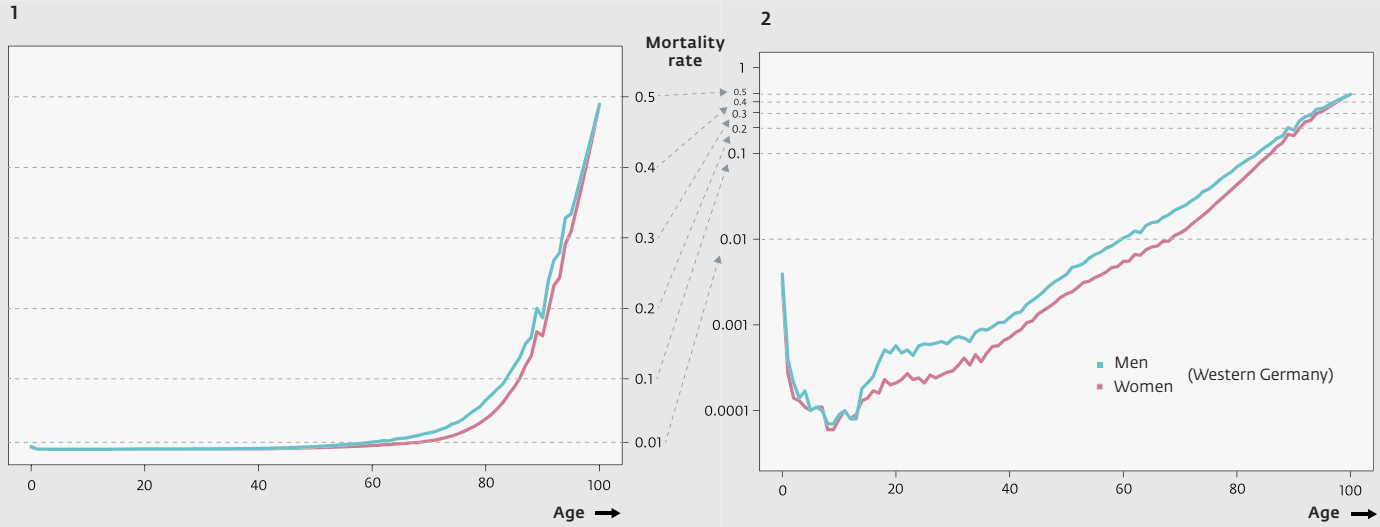
Only as the increases add up, like compound interest on a savings account, does the amount become significant, making rates high and visible. Gompertz had read enough about mathematics to know that dynamic variables whose relative variation is constant obey an exponential function. And so he postulated the first statistical law of aging: mortality risk increases exponentially with age.

Mortality data from throughout the world now confirms that Gompertz was right. However, from childhood to young adulthood, mortality doesn't increase exponentially. In fact, in the first years of life, it falls, as even in developed countries, infants and young children continue to be at an increased risk of death. Once this critical phase is overcome, the risk is virtually zero for a few years.

Then there is a deviation from the Gompertz curve, attributable mainly to young men: in puberty, their mortality risk suddenly rises sharply, as they take more behavioral risks due to their hormone-driven desire to boast and impress. The death rate then remains at this higher level for a while until, at around the age of 40, the process that demographers generally refer to as "aging" finally sets in: the regular annual 10 percent increase in mortality. Surprisingly, this increase in aging has remained virtually unchanged, at least in more recent human history, as has the starting point at age 40.

"Thus, in simple terms, from 40 onward, people age at the same rate year for year," says Jutta Gampe. However, this doesn't explain why they age. A whole field of research, involving demographers, physicians and researchers from many other disciplines, is dedicated to meeting the challenge of putting forward a consistent theory.

Photo: Fotostudio Hagedorn



Graphics: MPI for Demographic Research (2)

They could probably agree that, from a certain age, the body slowly but surely becomes increasingly weaker and more infirm. In other words: from the age of 40, it goes steadily downhill.

If one wants to put it that way. It certainly is the case that, on the one hand, the mortality rate rises universally and inexorably, as Gompertz postulated. Even if the probability of dying in any one year remains well below 100 percent into old age, death will get us one day. But the human "life force," which has been reducing the level of mortality simultaneously across all age groups, and doing so permanently and lastingly, has long been counteracting this force of mortality. Even as we live, our chances of survival are thus increasing constantly compared with previous generations. We may not be able to escape death, but we are living longer than ever.

"It is at this point that a major misunderstanding often arises," says Jutta Gampe. She has had to deal with the same questions from audiences countless times when she has publicly lectured about the miracle of declining mortality: if aging still sets in at roughly 40, but people keep getting older, doesn't that automatically mean more years of infirmity, when we will have already gone so far downhill that we're nothing but old dodderers? Won't the extra years ultimately just be ones of illness and misery?

In such situations, Jutta Gampe tries to explain why this logic is wrong: the story of mortality risk, which for her current age of 51 has halved since her birth, can also be told in another way: the level of risk to which 51-year-old women were subject when Jutta Gampe came into the world is today not reached by women until they are 60. Every milestone on the mortality scale is thus reached later and later in life. "From this perspective, society is undergoing rejuvenation rather than degeneration," says Gampe. In other words, we are gaining years not only at the end of our lives, but throughout them.

REJUVENATION RATHER THAN DEGENERATION

At this point, the researcher pulls out the data on French women. It goes back to well before 1900, while the figures for Germany have large gaps due to the turbulence it experienced during the 20th century. The data on French women shows just how monumental the mortality revolution is: the risk of death that applied to a woman of 40 at the beginning of the 20th century now applies to a woman of 70. "So the aging process, as shown by the mortality figures, isn't extended or slowed down, but rather takes place later and later," explains Gampe.

Nevertheless, many people remain unconvinced that people are staying healthier longer just because they are dying ever later. This includes scientists. They argue that, to prove the theory of healthy aging, it would first have to be proved that it really is their better physical condition that is allowing people to survive longer, and not just better respirators, mechanical hearts or other costly medical technology and drugs that are delaying death artificially without making this longer life active and worthwhile.

Conclusive evidence is not yet available. However, numerous studies have been carried out into the grip strength of hands, susceptibility to illness or mobility in old age, in the hope of finding a good indicator of better physical condition. There are many positive indications, but the picture isn't uniform, and the research is still ongoing. In the meantime, Jutta Gampe wonders why it is so difficult to convince the critics.

In her opinion, the burden of proof should be the other way around: "I feel that what really needs to be explained is how the aging process could have been pushed back by almost 30 years in just one century without people becoming fitter and healthier," she says.

Still, the skeptics are very obstinate. Of course they concede that, several decades ago, major medical progress was made in combating child and youth

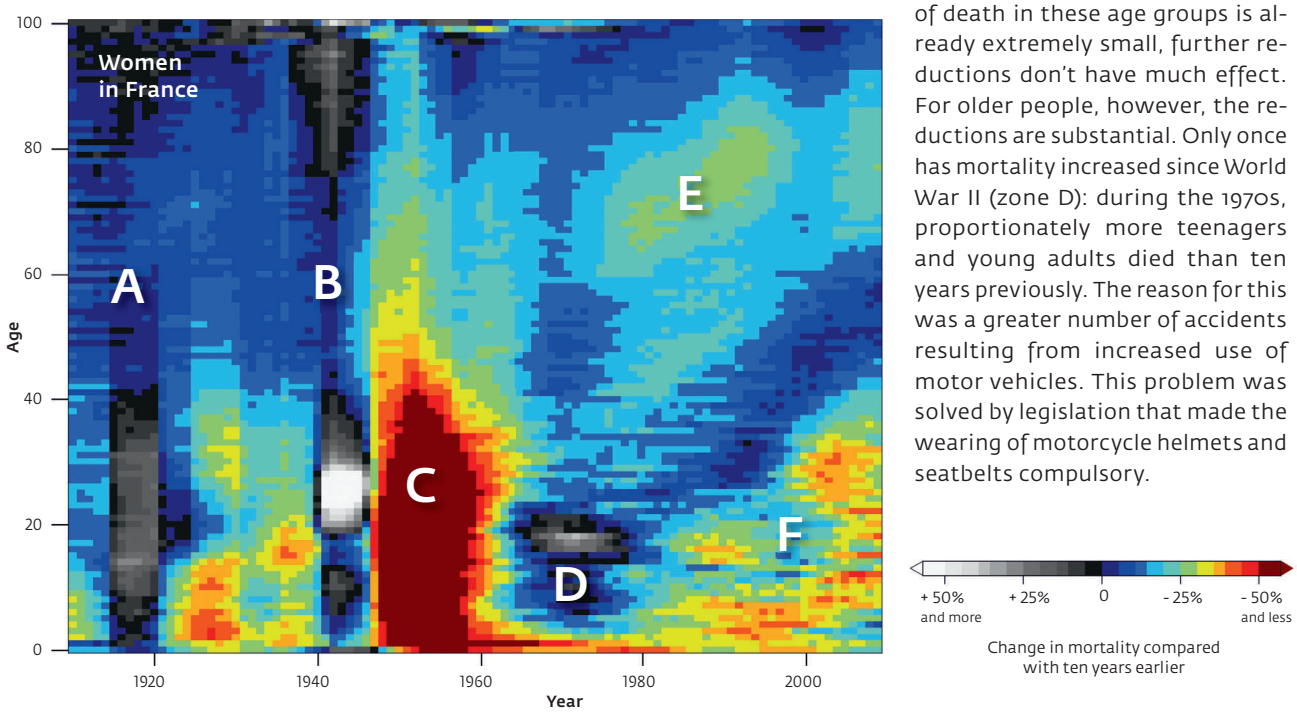
SURVIVAL MAP

The joys and tragedies of the history of human survival make for a colorful picture when the percentage changes in mortality risk over a century are visualized. Each color dot indicates an improvement (decline in mortality rate) or deterioration (increase in mortality rate) in a particular year compared with the situation ten years previously.

Most areas are colored blue to red, an indication of a constant reduction in mortality. But there were two major setbacks: In 1918, not only was World War I still raging, but Europe also fell victim to the Spanish Flu (black-grey spot in zone A), causing the death of millions of French people. World War II was even more devastating (zone B). It affected all age groups, but children and young adults were hit hardest of all. The white-grey patch in zone B denotes increases of 200 percent or more.

Fortunately, chances of survival soared again after the war, just as they had previously dropped like a stone. The dark red zone C denotes a good ten years during which significant decreases in mortality of up to 100 percent made up for the effects of the war.

Since World War II, mortality has been improving continuously – and that among ever older age groups. The greenish-yellow patches in and to the right of zone E show that death rates for the over-60-year-olds have been falling by up to 30 percent every ten years. Children and young people (zone F) have also seen major percentage reductions. However, since the likelihood of death in these age groups is already extremely small, further reductions don't have much effect. For older people, however, the reductions are substantial. Only once has mortality increased since World War II (zone D): during the 1970s, proportionately more teenagers and young adults died than ten years previously. The reason for this was a greater number of accidents resulting from increased use of motor vehicles. This problem was solved by legislation that made the wearing of motorcycle helmets and seatbelts compulsory.



mortality. But these successes can't be extended into old age because people, quite simply, wear out. Jutta Gampe has data to counter this argument, too: previously, the mortality risk for children and youth actually declined by the greatest percentage.

But since then, the improvements have shifted to older age groups. At the latest since the 1970s, the gains in longevity have stemmed primarily from reductions in mortality in the over-60s and increasingly older age groups. And the trend appears to be continuing. There are still considerable gains to be made at the latter end of life. Now, what used to be the end of the road is suddenly receding into the distance.

This data may suggest a mortality miracle, but no one should rest on their laurels, warns Gampe. The mortality risks to which they relate are only averages, applying to the entire population, and individual figures can be much higher – or lower. Individual mortality levels also depend on one's own behavior and on the hand an individual was dealt in terms of health at birth or early in life.

What interests Jutta Gampe is the question of whether speed of aging – the increase in mortality risk with age – also varies from person to person. James Vaupel, Founding Director of the Max Planck Institute for Demographic Research, just initiated a large-scale program to examine precisely this. His hypothesis is that it is not just

Graphic: MPI for Demographic Research

the population average that is seeing a uniform percentage increase in mortality rate, but also every individual.

KNOWLEDGE EXTENDS LIFE

This would mean that, in principle, all people age at the same pace. The relative speed at which their mortality risk grows per year of life would then be a natural constant. According to this theory, no one human being would naturally have a tendency to age for a longer period than any other. But this doesn't exclude random bad luck. It is, after all, sadly the nature of risk that an individual may be taken early by a terrible illness, or have to live with health impairments due to an accident or an inherited genetic defect.

"Despite all this, there is still plenty of scope for bringing down one's individual risk level through healthy behavior," says Jutta Gampe. "Everyone can push back the aging process for themselves." Researchers are now well aware of the most significant determining factors: not smoking, eating a diet that is high in vitamins and not too rich, exercising, avoiding excessive stress. But above all, we must keep learning. A high level of education is the most important factor in achieving low mortality. So the prospects are good for the knowledge society, as knowledge extends life. ◀

Human Mortality Database
www.mortality.org

TO THE POINT

- **Demographic change is often misunderstood: The statement "We are getting older and older" is true, but it doesn't mean that society will soon consist only of doddery old people.**
- **Aging continues to set in at the age of 40. However, the risk of death is being pushed back. During our own lifetimes, our chances of survival are increasing constantly compared with previous generations.**
- **We are gaining years not just at the end of our lives, but overall. From this perspective, society is undergoing rejuvenation rather than degeneration.**