From the creator of Radio 4's *More or Less*
& Professor of Risk at Cambridge
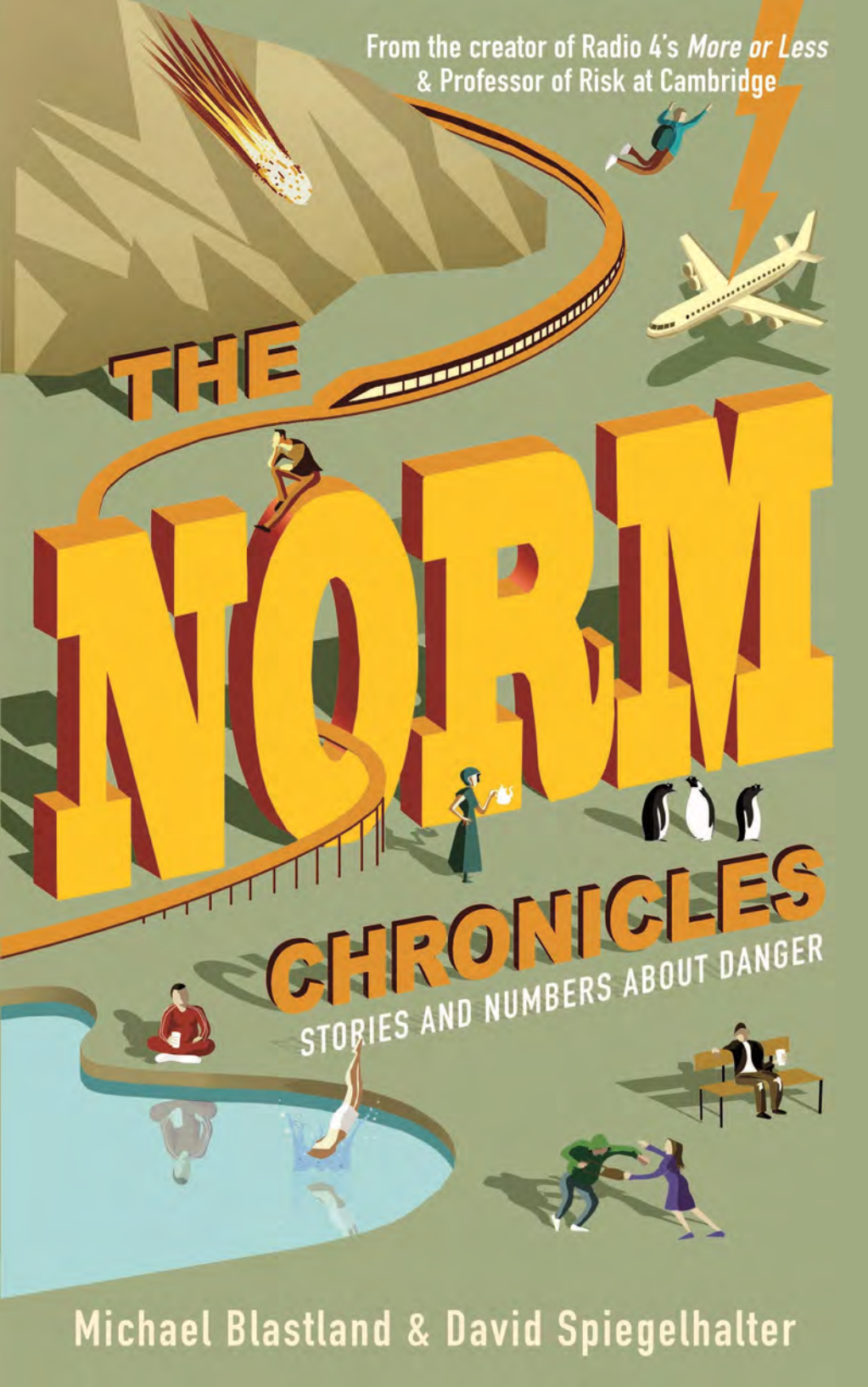
THE NORM

CHRONICLES

STORIES AND NUMBERS ABOUT DANGER

Michael Blastland & David Spiegelhalter

THE
NORM
CHRONICLES

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Stories and Numbers about Danger

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and
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LIFESTYLE

Norm lay in bed, eyes shut, listening to his body. He was mid-dle-aged and felt it. His body told him that it hurt.

He had recently taken up exercise after studying the data on chronic illness over lunch with Kelvin: a burger for Kelv, a salad for Norm. Run-ning was his attempt to slow the raindrop as it trickled down the win-dow. Although there were other consolations too. For example, beer tasted better afterwards, bitter with the sweet taste of righteousness.

So for twenty minutes each day on 200mg of flecainide acetate to control his cardiac arrhythmia, paunch creeping over the band of his shorts, he forced his feet down lanes lined with brambles or through damp leaves by the canal, blowing hard at the lid of his closing coffin, then sucked the air back like a glutton. He heaved his carcass all the way up to jog speed, nearly, until the aches were washed out by adrenaline. This was what it was all about. This was striving.

'Commit, Norm, commit!'

He pushed again until his body screamed that it was alive and feeling too much, all to counter the long hours when it seemed to feel nothing but fed up. He drove his thin legs and squeezed wheezing lungs to prove his frame could raise one more militant shout against age and wouldn't be dried and silenced. When he was running, he was living; it was trans-cendent and for ever, for 22 minutes. And Norm knew precisely how much extra life 22 minutes of exercise was worth, on average.

He finished. He slumped, while every muscle said it was spent and he wondered if he could have sustained his Mo-Farah finishing burst from the gate into the allotment instead of waiting for the lane. And he looked at his watch and he saw – and sighed – that he was, after all, at 22 minutes and 18 seconds, slower. Now he could go to the pub.

LIFESTYLE IS A new kind of danger to Norm. The hazards he's lived with so far have been instant, like violence or accidents, the kind that hit us over the head with a swift goodnight. But Norm is now running from a more sinister threat, another type of mortal hazard with slower effects that go stealthily into the blood one cancerous bacon butty or poisonous pint at a time, potential killers by degrees that might catch up with us later in life, as something surely will.

The first mortal hazard – the quick one – is known as acute risk; the second is chronic. Murder with a chainsaw is an acute risk, obesity a chronic one that takes time to do its worst. Of course, the same hazard might be both: too much booze can do you in quickly when you fall under a bus, or slowly stew your liver. But in general it helps to separate them.

So far, we've used the MicroMort to describe acute risks. For chronic risks like obesity or Norm's current long-term lifestyle anxieties, we introduce a little device we have called the Micro*Life*. Here's how it works.

Imagine the duration of your adult life divided into 1 million equal parts. A MicroLife is one of these parts and lasts 30 minutes. It is based on the idea that as young adults we typically have about 1 million half-hours left to live, on average.*

Sounds unimpressive. But we like the MicroLife. It is a revelatory little thing. Like the MicroMort, it brings life down to a micro level that's easy to think about and compare: half-hour chunks, of which we have 48 a day. Think of it as your stock of life to use up any way you choose,

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* Life-expectancy for a man aged 22 in the UK is currently about 79, or a further 57 years, which is 3,418,560 minutes, or 20,800 days, or 500,000 hours, or 1 million half-hours. For a woman, life-expectancy is about 83, so her million half-hours start at 26. This will not be true for everyone, but short of clairvoyance it'll do, roughly, more or less, overall.

1 million micro bits of a whole adult life, each worth half an hour, yours to spend. Watching the Eurovision song contest? Bang, 6 MicroLives gone, just like that, never to have again.

So the simple passing of time uses up MicroLives. Every day we get up, move around, stuff tasty things into our bodies, discharge smelly things out of our bodies and go to bed – perhaps with the thought, if we're gloomy, that there go another 48 MicroLives from our allotted span.

But extra MicroLives can also be used up by taking chronic risks. So although time passes to its own beat, our bodies can age faster or slower according to how we treat them. If we jump around more, and stuff less or better, how much can we slow the steady tick-tock towards disease, decrepitude and death? And if we indulge and slob, how fast might our own clocks run?

In other words, MicroLives can measure how fast you are using up your stock of life, faster or slower depending on the chronic risks to which you're exposed. If your lifestyle is chronically unhealthy, you'll probably burn up your allotted MicroLives that much quicker, and die sooner, on average.

For example, lung cancer or heart disease often follows a lifetime's smoking, and subsequently reduces life-expectancy – again not for everyone, but overall. Some people seem indestructible, smoke like a chimney and drink like a fish and never look the worse for it. But, on average, even if chronic risks don't kill you straight away, they tend to kill you sooner than if you had avoided them. Again, if we count the bodies, we can estimate how many years are lost overall, whether to obesity, smoking or sausages, and we can convert this loss of life into the number of MicroLives burned up by unhealthy living. Thus, exposure to a chronic risk equal to 1 MicroLife shortens life on average by just one of the million half-hours that people have left as they enter adulthood.

It turns out that one cigarette reduces life-expectancy by around 15 minutes on average, and so two cigarettes costs half an hour, or 1 MicroLife. Four cigarettes are equal to 2 MicroLives.

About two pints of strongish beer is also 1 MicroLife. Each extra inch on your waistline costs you around 1 MicroLife every day, seven a week, about 30 a month and so on. According to recent research, so

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does watching two hours of TV. An extra burger a day is also about 1 MicroLife. We'll reveal the calculations behind these risks in a moment.

We could simply add up all these MicroLives, half-hour by half-hour, to see roughly how much time on average you lose in total from whatever your lifespan might have been. But the end of life is often far away, like the end of the story, and a lost half-hour deferred until you are in your dotage hardly seems to count. As a media doctor said: 'I would rather have the occasional bacon sarnie than be 110 and dribbling into my all-bran.' But by thinking of exposure to chronic risks like an acceleration of the speed at which you use up your daily allotment of MicroLives, we can do something more vivid and immediate. We can show how much your body ages each day according to the chronic or lifestyle risks that you take.

Ordinarily, remember, we use up 48 MicroLives (MLs) a day. But remember, too, that smoking four cigarettes burns an extra 2 ML. So if you smoke four cigarettes in a day, you've used not 48, but 50 ML that day. In other words, after a 24-hour, four-fag day, we could say that you are 25 hours older.

And that's not a bad representation of what can happen biologically. Bodies do often age faster when we do bad stuff to them. Twenty cigarettes daily means you burn an extra 10 ML a day on average, or become 29 hours older with every 24 that pass, or move towards death five hours faster, every day.

Suddenly, chronic risk feels a lot more here and now than the far-away payback that we typically put off thinking about until we're spent anyway. It counters what is sometimes known as temporal discounting. By bringing chronic risk down to the small scale of what happens today, rather than thinking of it only as a life-size problem deferred, the Micro-Life makes chronic risk a good deal more real and immediate.

But should it? You might argue with this. You might prefer to put off facing up to your lifestyle risks. You might argue that you shouldn't be confronted with the payback until it actually occurs, late in life. On the other hand, it could be argued that the damage is done now, at the point of consumption, so we should measure it now.

MicroLives allow us to make simple comparisons of chronic risk, just as we did for acute risk with MicroMorts. Now we can compare

sausages with drinking or smoking, X-rays with mobile phones. We can compare a CT scan with watching the Hiroshima atomic bomb from the Hiroshima suburbs, getting fat with getting fit, unprotected sex with unprotected sun – and we will. In Chapter 27, Figure 37 shows a selection of MicroLife hazards.

If calculations terrify you, move swiftly on to the next chapter. Because next, we'll find out exactly how these calculations are done and what the evidence is for the MicroLife costs and benefits we've identified. Treat it as a statistical detective story.

We begin with the 1 ML cost of an extra burger every day, mentioned earlier. This was reported in the *Daily Express* in a story about the dangers of red meat, based on a study from Harvard University.[1] The *Express* said: 'If people cut down the amount of red meat they ate – say from steaks and beefburgers – to less than half a serving a day, 10 per cent of all deaths could be avoided.'

Oh to be one of the 10 per cent for whom death could be avoided! But this is not what the study said. Its main conclusion was that an extra portion of red meat a day – this being a lump of meat around the size of a pack of cards or slightly smaller than a standard quarter-pound burger* – is associated with a 'hazard ratio' of 1.13: that is, a 13 per cent increased risk of death. Put aside any doubts about the validity of this number for a moment and take it at face value. What does it mean? When our risk of death is already 100 per cent, surely a risk of 113 per cent is an exaggeration?

Let's consider two friends – whom we'll call Kelvin and Norm – who are both aged 40, and just for the moment let's make the unrealistic assumption that they are pretty much alike in most lifestyle respects that matter, apart from the amount of meat they eat.†

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* Actually 85 grams, or about 3 oz.
† The assumption is – in line with the Harvard study – that they have the same average weight, alcohol intake, exercise regime and family history of disease, but not necessarily quite the same income, education and standard of living. This is how the Harvard team analysed the risks, by trying to focus on the effect of the meat we eat without too many other factors in the way.

Carnivorous Kelv eats a quarter-pound burger for lunch from Monday to Friday, while Normal Norm does not eat meat for weekday lunches, but otherwise has a similar diet to Kelvin's. We are not concerned here with their friend Particular Pru, who has given up eat meat and turned veggie after reading the *Daily Express*, but who might succumb to a contaminated sprouted fenugreek seed.

Each person faces an annual risk of death, the technical name for which is their 'hazard' or, somewhat archaically but poetically, their 'force of mortality' (for a fuller discussion of the force of mortality, see Chapter 26, 'The End'). A 'hazard ratio' of 1.13 means that, for two people like Kelvin and Norm, similar apart from the extra meat, the one with the risk factor – Kelvin – has a 13 per cent increased *annual* risk of death – not an overall risk, obviously – during a follow-up period of around 20 years.

This does not imply that his life will be 13 per cent shorter. To work out what it really means we have to go to the life-tables provided by the Office of National Statistics. These tell us the risk that an average man – Norm, say – will die at each year of age. In 2010 this risk or hazard was at its lowest for those aged seven (see Chapter 2, on infancy), at 1 in 10,000: it then rises to 1 in 1,000 at age 34, then to 1 in 100 at age 62, until at age 85, 1 in 10 will die before their 86th birthday. So very roughly the annual chance of death increases tenfold around every 27 years, which works out at doubling every nine years, or about a 9 per cent extra risk of dying before the next 12 months are out, for every year that we are older. The tables also tell us life-expectancy at any given age, assuming the current hazards, and, having survived to age 40, Norm is expected to live a further 40 years, until he is 80.

From this we can work out Carnivorous Kelv's prospects by multiplying all Norm's hazards by 1.13. After a little work in a spreadsheet, we find that Kelvin can expect to live 39 more years on average, a year less than Norm. So Kelvin's lunch – if he eats the same lunch all his life and if we believe this hazard ratio – is associated with the loss of one year in expected age at death, from 80 to 79.

Is that a lot? Kingsley Amis said, 'No pleasure is worth giving up for the sake of two more years in a geriatric home at Weston-super-Mare.'[2] It is for readers to decide. But we cannot say that precisely this amount of

time will be lost. We cannot even be very confident that Kelvin will die first. In fact, there is only a 53 per cent chance* that Kelvin will die before Norm, rather than 50:50 if they eat the same lunch. Not a big effect.

But it sounds rather more important if we say that this lost year (1/40th of the remaining life) translates very roughly to one week a year, or roughly half an hour a day. So one extra MicroLife burned up for each daily burger. So, unless you're a very slow eater, you expect to lose more life than the time it takes to eat your burger.

But we can't even say the meat is directly causing the loss in life-expectancy, in the sense that, if Kelvin changed his lunch habits and stopped shovelling down the burgers, his life-expectancy would definitely increase. Maybe there's some other factor that both encourages Kelvin to eat more meat and leads to a shorter life.

Income could be such a factor – poorer people in the US tend to eat more burgers and also live shorter lives, even allowing for measurable risk factors. But the Harvard study does not adjust for income, arguing that the people in the study – health professionals and nurses – are broadly doing the same job. We think that many of these studies about diet should be taken with a pinch of salt (although perhaps not too much, since it may increase your risk of heart disease).

We can also look deeper into the calculation for other bad behaviours that receive a finger-wagging. So, next, smoking. The evidence against smoking is much better than that against red meat. In terms of shortening your life, a very basic analysis estimated a 6.5 years difference in life-expectancy between smokers and non-smokers, which is 3,418,560 minutes.[3] They considered median consumption of 16 cigarettes a day from ages 17 to 71, which comes to 311,688 cigarettes. Making the simplifying assumption that each cigarette contributes equally to the risk, this comes to 11 minutes loss in life-expectancy per cigarette, or around 3 cigarettes for a MicroLife.

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* If we assume a hazard ratio h is kept up throughout their lives, then some rather elegant maths tells us the probability that Kelvin dies before Norm is precisely $h/(1+h)$, which when $h = 1.13$, = a 53 per cent chance Kelvin dies first, rather than 50:50 if they eat the same red meat.

Figure 20: **Some MicroLives: how many gained or lost for different activities**
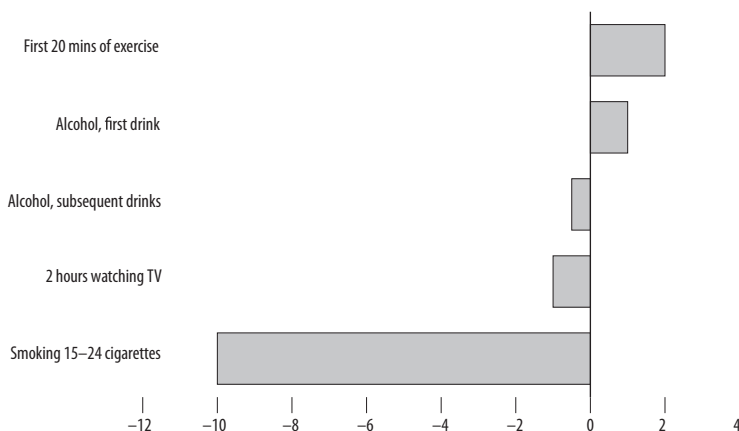
This simple analysis only compares smokers with non-smokers, who may be different in all sorts of ways that could also influence their health. A more sophisticated analysis would consider the effect of stopping smoking, and fortunately that's been done in a classic study on 40,000 UK doctors, many of whom gave up smoking during the period of the study from 1951 to 2001.[4] They estimate a 40-year-old man who stopped smoking gained 9 years in life-expectancy, or 78,000 hours in total, and from this we can estimate around 2 cigarettes for a MicroLife. So 2 ciggies is roughly equivalent to 1 burger, when taken daily.*

So what about the booze? The precise effect of alcohol on all-cause mortality is controversial since, although it can cause accidents (particularly for drivers and young binge-drinkers), give you liver disease and increase the risk of some cancers, it can also protect your heart. So the 'dose-response' curve for annual risk is J-shaped in middle age, meaning

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* If he carries on smoking, he is only expected to live another 30 years or 11,000 days, so he is on average losing 7.2 hours per day (14 MicroLives): we can imagine him speeding recklessly towards his death at 31 hours a day. During these 30 years he might smoke 325,000 cigarettes (assuming the higher consumption of 30 a day in the 1950s and 1960s). This works out at 15 minutes lost per cigarette smoked.

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that the risk falls slightly with the curve of the 'J' as you consume a small amount of alcohol, then rises as you consume more. Very roughly, it looks like the first drink each day adds a MicroLife, but extra drinks take it away again, and more. So the first is medicine, the second poison, the third poison and so on. It does *not* go medicine/poison/medicine/poison ... – that would be ridiculous, and would mean that one would need to have an odd number of drinks.[5]

All this is depressing, but what about the benefits of a good diet and hearty exercise – eating muesli and running (although not at the same time)? As A. A. Milne said, 'A bear, however hard he tries, grows tubby without exercise', and we can try and work out what that tubbiness might do to your life. A recent review estimated a risk * which translates to around 1 ML lost for every day that you are 5 kg overweight.[6] Seriously obese people can lose ten years off their life-expectancy, similar to smokers.

The European Prospective Investigation into Cancer and Nutrition (EPIC) study in Norfolk compared people who ate their five portions of fruit and veg a day with those who didn't (and the researchers checked their honesty about their diet by measuring vitamin C levels in their blood).[7] The hazard ratio was 0.69, showing around 30 per cent less annual risk associated with a better diet, or around 3 ML a day saved, as if they were only ageing 22.5 hours instead of 24.

And all that running around? The UK guidelines recommend we all take 30 minutes moderate or vigorous activity on five days each week – a total of 2.5 hours per week or 22 minutes a day. When asked in 2008 about their physical activity, 39 per cent of men and 29 per cent of women claimed they did this much exercise each week.[8] However exercise, like sex, tends to be over-reported, just as alcohol is under-reported – if we believed what people say they drank, half the alcohol bought in the UK must be left in the bottle or chucked down the sink.

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* The study gives an estimated hazard ratio of 1.29 for all-cause mortality per 5 kg/m^2 increase in body mass index (BMI) over the optimum of 22.5 to 25 kg/m^2. For a man/woman of average height (1.75m/1.62m), this corresponds to a hazard ratio of around 1.09 per 5 kg overweight, translating to one MicroLife per day.

Which we doubt. When people carry accelerometers that measure their true exercise, only 6 per cent of men and 4 per cent of women meet the government-recommended levels of activity. We are part of a population that is both tubby *and* deluded.

A huge review of 22 studies involving nearly 1 million people concluded that 2.5 hours a week of 'non-vigorous' activity was associated with a hazard ratio of 0.81 compared with being a complete slob – a 19 per cent reduction in annual risk of death.[9] This works out as about an hour per day, or 2 ML, added to life-expectancy for an average of 22-minutes-a-day activity, which must be why that's the length of Norm's run – quite a good return for the investment of getting off the sofa.

So it's a good idea not to be a couch potato, and a Swedish study even showed that it's never too late to start, with increasing physical activity in middle age eventually bringing your risk down to the level of people who have always been active – similar to the benefits of giving up smoking.[10]

Some naive extrapolation would suggest that if we do lots of exercise we could live for ever, but sadly there is a strong law of diminishing returns. People who do 7 hours moderate exercise a week, a full hour per day, only reduced their risk by 24 per cent, equivalent to about 1.5 hours added to their life for each day of exercise.

So, very roughly, compared with doing no physical activity, the first 20 minutes or so per day pays rich dividends, but any more than that is approximately pro rata: 20 minutes of exercise earns you 20 minutes of added life-expectancy. It's like time stops for you when you're exercising. And on a treadmill it can certainly feel that way.

Our circumstances when we're born – which we can't do much about – can also be expressed in MicroLives. For example, being female rather than male (worth an extra 4 ML, or two hours per day), being Swedish rather than Russian (21 a day for males, or more than ten extra hours) and living in 2010 rather than 1910 (15 a day, or 7.5 extra hours).

Of course, working out the health effects of lifestyle is not a precise art. It is impossible to put exact numbers on the harm we do to our bodies with an extra cigarette, sausage, pint of beer or glass of wine, or the lack of five-a-day fruit and veg, or – on the virtuous side – the benefits

we might reap on the exercise bike or by being otherwise wholesome and pure.

But we can calculate the effects approximately, by averaging over many lifetimes, and it is worth trying, especially in a world of exhortations to self-improvement or stories of how you too can stay forever beautiful and young – or not.

There is one big difference between MicroMorts and MicroLives. If you survive your motor-bike ride, your MicroMort slate is wiped clean and you start the next day with an empty account. But if you smoke all day and live on pork pies, then your used-up MicroLives accumulate. It's like a lottery where the tickets you buy each day remain valid for ever – and so your chances of winning increase. Except that in this case you really don't want to.

People spend a fortune on cigarettes, but what would you sell half an hour of your life-expectancy for? Governments put a value on MicroLives, as they do with MicroMorts. The UK National Institute for Health and Clinical Excellence (NICE) has guidelines that suggest the National Health Service will pay up to £30,000 if the treatment is expected to prolong life by one healthy year. That's around 17,500 ML. This means that NICE prices a MicroLife, or half an hour of your remaining life-expectancy, at around £1.70, almost exactly what the Department of Transport says it would pay to avoid a MicroMort.

Does this mean the government ought to pay you £1.70 for every two cigarettes you resist or for every day that you keep that extra inch off your waistline? Possibly, except that it wouldn't work like that: we could all claim to resist hundreds of cigarettes a day, non-smokers especially.

Now that Norm is into middle age and full of regret for the burgers that slipped through in earlier life,* puffing hard to put time back in the bank, it's interesting to note that he hasn't become pure, merely smug. A 22-minute run might buy him an extra hour of life, but one effect is that he feels happier about spending it in the pub.

His behaviour is known as risk compensation, related to the idea in

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* Kelvin? Il ne regrette rien.

Figure 21: **Scandinavian orange juice**
But if you live longer than your friends, who will you talk to?

Chapter 15, on transport, that we all have an in-built risk thermostat. Taken your vitamins? Great. Eat extra chips!

There's experimental evidence to support this.[11] In one trial, in a culture of heavy smokers, some participants were given pills and told they could have a cigarette break. All the pills were placebos. But those who thought they'd taken a vitamin pill were far more likely to go for a smoke (89 per cent to 62 per cent). In another study surveying people's sense of vulnerability, those who took vitamin pills somehow thought they were less likely to be hurt in an accident.

So if you've banked some health, you might feel free to spend it. How these attitudes and behaviours shake out – some beneficial, some compensatory and harmful – takes some calculating, except for vitamin pills, which don't do most people much good anyway. But it does suggest that the risk calculation for healthy behaviour also needs to take account of the cream cake afterwards.

A summary of the research on exercise suggests that it still brings substantial benefits, although less weight loss than you might hope, perhaps because people eat more.[12] The research does not suggest that exercise leads people to eat so much more that they become fatter on average, contrary to much online gossip. But do mind that you don't seek too much cake compensation for all your hard work.