

The chair is winning

A short book about sitting for most of the day and treating stiffness and low energy as age

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First edition

Written by AI with human guidance. It can contain mistakes, which later editions correct.

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Before you start

This is a short book and you can read it in two or three sittings. I notice the irony of that word. If you like, read some of it standing up.

It's about one habit, though most people who have it wouldn't call it a habit. You sit in the car, then at a desk, then at a table, then on the sofa. Nobody decided this. It's how work, travel and evenings are arranged. Somewhere in your forties or fifties you start to feel stiff when you stand up and flat by mid-afternoon, and you put both down to your age.

I'm going to argue three things. The first is that a good share of what you're calling age is the effect of not moving, which is a different thing and behaves differently. Age only runs one way. The effects of not moving can be reversed, and there's evidence for that in people of fifty and in people of ninety. The second is that the usual answer, which is to join a gym, misses the point for most people. An hour of exercise is good for you, but it doesn't reach into the other twelve hours of sitting unless it's a lot of exercise. The third is practical. You get up every half hour, and you walk for ten minutes a day. Chapters 13 to 15 cover how, and what to do when your job or your body makes that awkward.

Nothing in this book asks you to stop sitting. Sitting is a fine thing to do. You can't do most jobs, eat a meal or watch a film without it. The argument is about long unbroken stretches and about days with almost nothing else in them.

Four cautions.

If you haven't been active for some time, or you have a medical condition or any concerns, the NHS advice is to speak to a GP before you start exercising. Nothing in this book is strenuous, but that advice still applies to you, and a GP can tell you what suits your heart, your joints and your medicines.

If you've been tired for a few weeks and you're not sure why, or tiredness is affecting your daily life, the NHS advice is to see a GP. The same goes if you're tired and you've also lost weight, your mood has changed, or you've been told you gasp, snort or choke in your sleep. Tiredness has many causes. This book deals with one of them, and I'd like you to have the others ruled out.

If you get chest pain, stop what you're doing. The NHS says to call 999 if you have sudden chest pain or discomfort that doesn't go away, pain that spreads to your arm, neck, jaw, stomach or back, or chest pain with sweating, sickness, light-headedness or shortness of breath.

And if you have ME, also called chronic fatigue syndrome, or you're living with long Covid, most of this book doesn't apply to you. Your tiredness isn't the kind I'm describing, and pushing through it can make you worse. Chapter 15 says a little more. The same chapter has a section for readers who use a wheelchair or can't stand.

The notes at the back give my sources and their limits. Where I'm giving my own reasoning and not a finding, I'll say so.

Wednesday, twenty to seven

It's twenty to seven on a Wednesday evening and the doorbell goes. You're on the sofa with your feet up. You put one hand on the arm of the sofa, push, and make a noise as you stand. It's somewhere between a grunt and a sigh, and you've been making it for a year or two without deciding to.

The first three steps are the odd ones. Your hips feel as if they belong to somebody else, your lower back is set in the shape of the sofa, and one knee takes a moment to agree to bend. By the time you reach the front door you're walking normally. It's a parcel for next door. You take it in, go back to the sofa and sit down again.

You're fifty-four. You've noticed this kind of thing more and more. Getting out of the car after the drive home takes a moment of unfolding. When your grandson Alfie wants you down on the floor with his train track, getting down is fine, and getting up again needs a hand on the coffee table. At the multi-storey you take the lift for two floors, which you wouldn't have done at forty. Around three every afternoon your energy goes, and you get through to five on tea and whatever's in the drawer.

You have an explanation for all of it, and it's a reasonable one. You're getting older. You remember your father making exactly that noise when he got out of his armchair, and he was about the age you are now. It's what happens.

Here's the rest of that Wednesday, which you haven't thought about because there was nothing in it to notice. You got into the car at twenty to eight and drove thirty-five minutes to work. You were at your desk from half past eight until five. You ate a sandwich at the desk, because there was a lot on. From two until half past three you were in a meeting. Across the working day you were on your feet for perhaps forty minutes in total, going to the kettle, the printer and the loo. You drove home, sat at the table for dinner, and were on the sofa by seven.

Add it up. The car comes to an hour and ten minutes, the desk and the meeting room to not quite eight hours, and meals to forty minutes. The sofa, by bedtime, will be three and a half hours. That's a little over thirteen hours of sitting in a waking day of sixteen and a half. When the doorbell rang you'd been sitting since seven without a break, and before that since five with only the walk from the car to the house.

There's a woman at your work called Denise who's sixty-one. She walks a circuit of the industrial estate every lunchtime, in all weathers, and she takes the stairs. You've always filed her under "one of those people". It hasn't occurred to you that the difference between how she moves and how you move might have more to do with the lunchtimes than with the kind of person she is.

I'll use a few terms throughout. **The tally** is the number of hours you sit in an ordinary waking day. **A long sit** is an hour or more in a chair without standing up. **A break** is standing up and moving about for a couple of minutes. **The age story** is the explanation that

your stiffness and tiredness are simply what your age brings.

Disuse is what happens to a body that's asked to do very little, and it's the main rival to the age story in this book.

The habit has some regular features. This list is my own observation and not a research finding.

Nobody chose it. Each hour of sitting came attached to something else, such as a drive, a job, a meal or a programme.

It's invisible. You could tell me roughly what you ate yesterday and how long you slept. Almost nobody can say how many hours they sat.

The costs arrive slowly and look like something else. Stiffness, tiredness and a shrinking list of things you feel like doing are what you'd expect from ageing, so that's the label they get.

It feeds itself. The stiffer and more tired you feel, the more attractive the chair becomes, and the more time you spend in it.

And exercise, if you do any, sits in a separate box. You can go to a class on Tuesday and Thursday and still have a tally of thirteen hours on both days.

Try one thing before reading on. Pick an ordinary working day and work out your tally. Don't change anything. Go through the day from getting up to going to bed and add up the hours in the car, at the desk, at the table and on the sofa. Then note the longest single stretch you sat without standing up. Most people who do this find the total is two or three hours higher than they'd have guessed.

Why the chair wins

If your tally has come out at eleven, twelve or thirteen hours, you may be feeling that you've been lazy. I don't think that's the right word, and I don't think it's a useful one.

Look at how the hours got there. You didn't sit in the car because you like sitting. You sat because that's how you get to work. You sat at the desk because that's where the screen is, and the screen is where the work is. You ate at the desk because there was a lot on. The meeting was held around a table because meetings are. None of these was a decision about sitting. They were decisions about travel, work and food, and sitting came with each of them.

You're also typical. The NHS says that many adults in the UK spend more than seven hours a day sitting, and that people over sixty-five spend ten hours or more sitting or lying down, which makes them the most sedentary age group. Researchers who fit office workers with motion sensors report that they typically sit for between 70 and 85 per cent of their working hours. If your tally is high, you're living the way most people with a desk job live.

The world was rearranged to produce this, mostly within living memory, and mostly for good reasons. The NHS puts it plainly. We drive or take public transport, machines wash our clothes, fewer people do manual work, and shopping, housework and other necessary jobs take far less effort than they did for earlier generations. Nobody wants the mangle back. But each of those improvements removed some movement that people used to get without thinking about it, and nothing replaced it.

Then there are the reasons the chair is attractive in itself, and they're real.

Sitting is comfortable. After a day of work, your body asks for the sofa, and the first minute on it is one of the day's small pleasures.

Sitting looks like working. At a desk, the person who's seated and staring at the screen appears busy, and the person who's wandering about appears not to be. Many people feel watched when they stand up.

Sitting is the polite default. You sit in waiting rooms, in other people's houses, on trains and in meetings, because standing when others are seated feels odd.

Sitting feels like the sensible response to being tired and stiff. If your body aches when you move, moving less seems like looking after it.

And the alternative seems to be exercise, which you may not like, may not have time for, or may feel you've failed at before. If the only choice on offer is between the sofa and the gym, the sofa is going to win most evenings.

Underneath these are needs nobody should be ashamed of. You want to rest when you've worked, you want to get your job done without drawing attention, and you want to look after a body that's complaining. The next several chapters ask whether long sitting serves those needs. I'll argue that it serves the first for about twenty minutes and then works against all three.

"It's my age"

The age story deserves to be taken seriously, because part of it is true. Bodies do change with the years. Muscle gets harder to keep, recovery slows, and joints that have done fifty years of work show it. If I told you that age had nothing to do with how you feel, you'd be right to stop reading.

The question is how much of what you feel is age and how much is disuse. For most people the two have arrived together, so there's been no way of telling them apart. The more years you've lived, the more of them you've spent at a desk. You'd need an experiment that separates the two. There's a small, famous one that does.

In the summer of 1966, researchers in Dallas took five healthy men of twenty and put them to bed for three weeks. They weren't ill. The point was to see what complete rest does to a fit young body. The researchers measured each man's maximal oxygen uptake before and after. That's the most oxygen your body can take in and use when it's working flat out, and it's the standard laboratory measure of fitness. After three weeks in bed it had dropped sharply.

Thirty years later, Darren McGuire, Benjamin Levine and colleagues found the same five men, now fifty, and measured them again. Over three decades of ordinary adult life their maximal oxygen uptake had fallen by 11 per cent from where it stood in 1966. That was a smaller fall than three weeks in bed had produced

when they were twenty. The researchers' own summary was that three weeks of bed rest had a more profound effect on the men's physical work capacity than three decades of ageing.

The team went back again when the men were sixty. By then the total decline across forty years had reached 27 per cent. The drop after those three weeks in bed in 1966 had been 26 per cent. Forty years of living and three weeks of lying still came out about level.

I don't want to make this small study carry more than it can. It was five men. Bed rest is a far stronger dose of stillness than a desk job. Age did show up in the numbers. The decline between fifty and sixty was about four times as fast as between twenty and fifty, partly because some of the men had developed medical conditions by then. And over those thirty years they'd put on a quarter of their body weight and doubled their body fat, so the ageing being measured was the ordinary sedentary kind. That last point cuts both ways, and I'll come back to it in chapter 13, because the researchers then did something interesting with the men at fifty.

What the study shows is scale. People assume that age is the big force and inactivity a minor one. In these men it was the other way about. Complete stillness did in three weeks what age needed decades to do.

It isn't only the young who respond that fast. Patrick Kortebein and colleagues asked eleven healthy volunteers with an average age of sixty-seven to stay in bed for ten days. Nothing was wrong with them, and they were fed properly throughout. At the end of the ten days the strength of their thigh muscles was down by 13 per cent, their stair-climbing power was down by 14 per cent and their

aerobic capacity was down by 12 per cent. One further detail matters for this book. After the ten days were over and they were free to move as they liked, they moved less than they had before.

Your body runs on a simple policy, and I'm giving you my interpretation here and not a finding. It maintains what gets used and lets go of what doesn't. Muscle, heart capacity and the easy range of a joint all cost something to keep up, and a body that's asked for very little of them stops paying for them. It works the way a council treats a bus route. If nobody rides it for long enough, the service gets cut, and nobody at the council thinks of that as damage.

Now go back to the thirteen hours. A day like that isn't bed rest, but it's a diluted version of the same instruction, given daily for years. Your legs are asked to carry you for a few hundred yards in total. Your heart is never asked for more than it needs to keep you upright in a chair. The body draws the reasonable conclusion.

So when you stand up at twenty to seven and make that noise, the honest account is that two things are going on. One is that you're fifty-four. The other is that you've been still since five o'clock, and largely still for years. You can't do anything about the first. The rest of this book is about the second, which I think is the larger share, and which works in both directions.

One check you can run on yourself. Think of a time when you were forced to be far more active than usual for a week or two. It might have been a walking holiday, a house move, or a fortnight helping someone decorate. Most people remember being sore for three

days and then, by the second week, feeling looser and livelier than they had in months. If what you feel on the sofa were age alone, that fortnight wouldn't have made any difference to it.

"I'm tired, so I should rest"

At three in the afternoon your energy drops. At half past five you get home feeling finished. The obvious reading is that you've used up the day's supply, and the obvious response is to sit down and recover. It's what you'd tell anyone else to do.

This makes complete sense for one kind of tiredness. If you've spent the day laying paving slabs, carrying a toddler round a zoo or walking twelve miles, your muscles have done real work, and rest is what restores them. Bodies that have been used need rest.

But look at what your body did on that Wednesday. It sat. Your mind may have worked hard, and I don't dismiss that.

Concentrating for hours, dealing with people and making decisions is tiring in its own way. But the tiredness you feel at half past five doesn't come from physical work, because there wasn't any. Your legs aren't short of rest. They've had about thirteen hours of it.

So you're applying the cure for one kind of tiredness to a different kind, and it doesn't work. You've probably noticed this without putting it into words. An evening on the sofa after a desk day doesn't leave you refreshed. You go to bed as flat as you were at six, and often flatter.

There's an old experiment on this that I like. In the 1980s the psychologist Robert Thayer asked eighteen volunteers to try two things on different days, in the course of their normal lives. On some days they ate a chocolate bar. On others they walked briskly

for ten minutes. Each time, they rated their energy, tiredness and tension over the next two hours. After the ten-minute walk they reported more energy and less tension, and the effect was still there two hours later. After the snack they felt more energetic at first, but an hour later they were more tired than before they'd eaten it, and more tense.

Eighteen people rating their own feelings is a small study, and I wouldn't build a whole argument on it. It does match something you can test for yourself in an afternoon, and it points the opposite way from common sense. The thing that feels like spending energy left people with more of it, and the thing that feels like topping up left them with less.

Larger reviews point the same way, with a caveat I should give you. Timothy Puetz and colleagues pooled the trials in which inactive people were put on regular exercise programmes and asked about their energy. Across all of them, people on the programmes reported more energy and less fatigue than people in the comparison groups. But in the subset of trials that used a placebo comparison, such as a group given some harmless alternative activity and the same attention, the exercise groups did no better. So some of the lift people feel may come from expecting to feel better, or from the fact of doing something at all. For your purposes that may not matter much. It does mean I can't tell you that the effect is pure physiology.

The NHS takes the ordinary version of this for granted. Its page on tiredness lists common causes, and not getting much exercise is there alongside poor sleep and stress.

Here's how I think the pieces fit, and this is interpretation. Your sense of energy isn't a fuel gauge. It's closer to a setting that your body adjusts according to what's been asked of it lately. A body that's asked to move every day keeps itself ready to move, and readiness to move is a large part of what feeling energetic means. A body that's asked for nothing turns the setting down. The three o'clock slump, on this view, isn't a sign that you've done too much. It comes partly from having sat since half past eight, along with whatever your lunch and your sleep are contributing.

This gives you a trap with two sides. You feel tired, so you sit. Sitting asks nothing of your body, so it prepares for nothing, and you feel more tired. After a few years the tiredness seems like a fixed fact about you, and you explain it with the only explanation available, which is your age.

None of this means you should never rest, or that a sit-down after work is a mistake. It means that when you've been still all day, more stillness won't fix the tiredness you've got. Next time the slump arrives at three, try ten minutes of brisk walking before you reach for the tea and the drawer. Go round the building or the block. Then see how four o'clock feels.

"Stiff means worn out"

The noise you make when you stand up comes with a picture. In the picture, your joints are mechanical parts that have done a lot of miles. The stiffness is wear, like a hinge that's gone rusty, and the kind thing to do with a worn part is to use it less.

Test the picture against what happens at the front door. You stood up stiff. Three steps later you were less stiff. By the time you'd carried the parcel to the hall table you were moving normally. A worn hinge doesn't free up after three swings. Whatever eased in those few seconds wasn't damage, because damage doesn't ease by being used.

What you felt is better described as the state of a body that's been held in one shape for two hours. I'm simplifying, and the details differ from joint to joint, but the outline is well accepted. Muscles held short for a long time, such as the ones across the front of your hips when you sit, resist being lengthened in a hurry. Joints are lubricated by movement, and a joint that hasn't moved for a while is briefly less ready to. Tissues that have been sat on have been squeezed. All of this reverses within a minute or so of moving, which is what happened.

Notice when the stiffness is at its worst. It peaks first thing in the morning, after a long drive, and at the end of a film. It's at its lowest halfway through a day of pottering about. If stiffness tracked use, it would be worst after use. Yours is worst after stillness. The pattern points to stillness as the cause.

The wear picture does more than mislead you. It tells you to protect your joints by resting them, which means more stillness. That brings more stiffness, which you take as more evidence of wear. People can go round that loop for years.

There's a fair objection here. Some stiffness is more than the ordinary kind, because arthritis exists. Osteoarthritis is common from middle age on, and it's a real change in the joint. But look at what the NHS says to people who have it. It calls exercise one of the most important treatments for osteoarthritis, whatever your age or level of fitness. It acknowledges that if your joints are painful and stiff you may think exercise will make things worse, and says that regular exercise that keeps you active and builds up muscle usually helps to improve symptoms. So even where there's genuine wear in the joint, the medical advice is to move it.

I also owe you a correction to something you may have read, because it's the kind of claim a book like this would be tempted to make. It's often said that sitting at a desk wrecks your back. Darren Roffey and colleagues reviewed the research on whether sitting at work causes low back pain, and found strong and consistent evidence of no association. They concluded that occupational sitting is unlikely to be an independent cause of low back pain. So I won't tell you that your chair has injured your spine, because the best evidence says it probably hasn't. What I'm describing is milder and more general. Your body has adapted to being still and objects for a moment when asked to move. That isn't an injury.

I find that reassuring, and I hope you do. The grunt, the three odd steps and the hand on the coffee table tell you that you've been still for a long time. They don't tell you that your joints are failing.

Some kinds of stiffness and pain do need a doctor, and I'd like you to know which. The NHS advises seeing a GP about back pain that doesn't improve after a few weeks, that stops you doing your day-to-day activities, or that's worse at night. It advises urgent help if back pain comes with numbness or tingling around your genitals or bottom, loss of bladder or bowel control, or weakness or numbness in both legs. Joints that are swollen, hot or red are also worth taking to a GP, and so is morning stiffness that lasts much longer than half an hour. Ordinary sitting stiffness doesn't do these things. It eases within a minute or two of moving about.

"I go to the gym, so I'm covered"

Some readers will have reached this point feeling that the book isn't about them. You swim twice a week, or you go to a class, or you do a parkrun on Saturdays. You've done what the health advice asks. The tally of thirteen hours is just the background to a life that includes proper exercise.

You're better off than someone who does nothing, by a wide margin, and I don't want to blur that. But the two things turn out to be more separate than they look, and the evidence on how they interact is worth knowing.

In 2016 Ulf Ekelund and colleagues pooled data from studies that had followed more than a million men and women for up to eighteen years. For each person they had two pieces of information, which were how long they sat each day and how physically active they were. That let the researchers ask the question directly. Does activity cancel out sitting?

The answer was yes, at a price. Among people in the most active quarter, sitting for more than eight hours a day carried no detectable extra risk of dying during the follow-up. That most active quarter, though, was doing about sixty to seventy-five minutes of moderate activity every day. That's an hour or more of something like brisk walking, daily. It's four or five times the 150 minutes a week that the guidelines ask for, and far more than two classes and a swim.

Below that level, sitting time mattered. Among the less active groups, the more people sat, the higher their death rate over the follow-up. The worst placed were the people who were both the least active and sat for more than eight hours. Their death rate was 59 per cent higher than that of people who sat little and moved a lot.

I should be careful about what kind of evidence this is. These are observational studies. People reported their own sitting and activity, which they do inaccurately. People who sit a lot may differ from people who don't in ways the researchers couldn't fully adjust for, and some people sit a lot because they're already unwell. Nobody can run the ideal experiment, in which thousands of people are made to sit for twenty years. So treat the figures as the best available estimate.

Two further results from the same study are worth having. The first is about which matters more. People who sat for less than four hours a day but were in the least active group had a death rate 27 per cent higher than the most active group. People who sat more than eight hours but were in the most active group had almost no extra risk. So if you had to choose between the two, moving a lot beats sitting little. Your swimming counts for a good deal.

The second concerns the sofa. When the researchers looked at hours of television in place of total sitting, the picture was worse. Three or more hours a day in front of the television went with a higher death rate in every group except the most active, and even in that group the rate rose at five hours or more. Chapter 11 looks at why evenings might be different.

The NHS draws the practical conclusion on its page about sitting. It says that you can hit your weekly activity target and still be at risk of ill health if you spend the rest of the time sitting or lying down. Its guidelines for adults ask for two separate things. One is 150 minutes of moderate activity a week, and the other is to reduce the time you spend sitting and break up long periods of not moving.

So a Tuesday with an evening class in it still has a morning, an afternoon and a long sit from two until half past three. The class doesn't reach back into those hours. If you exercise, keep exercising, because on this evidence it's the most protective thing you can do. But the noise at twenty to seven on a Wednesday is a result of what you did between five and twenty to seven, and Tuesday's class doesn't change that.

"I'm not the exercising type"

Other readers will have the opposite worry. You don't swim or go to classes. You may have joined a gym twice and stopped going both times. If the people who exercise aren't fully covered, you might reasonably wonder what hope there is for you. And if the answer to sitting is an hour a day of brisk walking, you know already that you aren't going to do it.

This chapter has the most encouraging evidence in the book. It turns out that the largest gains are at the bottom of the scale.

The studies in the last chapter relied on people's own reports. Newer studies give people a motion sensor to wear for a week, which records every minute of movement, including movement nobody would think to call exercise. Ulf Ekelund and colleagues pooled eight such studies covering more than 36,000 adults with an average age of about sixty-three. They divided people into four equal groups by total movement and followed them for around six years.

Compared with the least active quarter, the next quarter up had about half the death rate over the follow-up. The steps after that gave further gains, but smaller ones. Most of the difference lay between people who barely moved and people who moved a bit.

The researchers also looked at light activity on its own. That's the kind that doesn't raise your pulse much, such as walking slowly, cooking, pottering, tidying and standing at a counter. The same pattern held. People who did more of it had lower death rates, and

the second quarter had about 40 per cent lower rates than the bottom one. For time spent sedentary, the pattern ran the other way, and the most sedentary quarter had more than two and a half times the death rate of the least.

The caution from the last chapter applies here with more force. People who are already ill move less, and they're also more likely to die, so some of this gap reflects illness causing stillness and not the reverse. The researchers took steps to reduce that problem, and I doubt it can be removed completely. The size of the differences is probably flattered by it. The direction is supported by the experiments in the next chapter, where the movement is assigned and the effect on the body is measured the same day.

Step counts tell the same story in a form you can check on your phone. Amanda Paluch and colleagues pooled fifteen studies covering about 47,000 adults. They note at the outset that there's little evidence behind the famous target of ten thousand steps. In their data the quarter of people who walked least took about 3,500 steps a day. The next quarter took about 5,800 and had a death rate 40 per cent lower. Beyond that the gains went on but flattened out, at around six to eight thousand steps a day for people over sixty, and eight to ten thousand for younger adults. For someone with a thirteen-hour tally, the useful distance is from three and a half thousand to six thousand. That's about twenty-five minutes of walking spread across a day.

One more finding speaks directly to people who don't exercise. Emmanuel Stamatakis and colleagues studied more than 25,000 adults who wore sensors and who reported doing no sport or exercise at all. Some of them nonetheless showed short bursts of

vigorous effort in the course of ordinary life. They climbed stairs fast, hurried for a bus or carried heavy shopping. Those who managed three such bursts a day, each lasting a minute or two, had a death rate 38 to 40 per cent lower over seven years than those who had none. It's observational again, with the same caveats. But none of these people would have described themselves as the exercising type, and their sensors agreed.

The belief this chapter examines rests on an assumption, which is that the alternative to sitting is exercise. For your body, the alternative to sitting is anything else. Standing at the worktop peeling potatoes counts as light activity. So does walking to a colleague's desk when you could have sent a message, and so does carrying the washing upstairs in two trips. The NHS list of what counts as light activity for older adults includes getting up to make a cup of tea.

You don't have to become someone who exercises in order to stop being someone who sits for thirteen hours. Those are separate projects. The second one needs no kit, no membership and no change of clothes, and on the evidence it's where the larger gains are.

"A couple of minutes can't matter"

The rule this book builds towards involves getting up for a minute or two every half hour. Put like that, it sounds too small to do anything. Two minutes of wandering about the office can't offset the twenty-eight minutes either side of it. It sounds like the kind of health tip that fills space in a magazine.

The best answer is an experiment, because here researchers could assign the movement and measure the result, which the big population studies couldn't do.

David Dunstan and colleagues in Melbourne recruited nineteen adults aged between forty-five and sixty-five, all of them overweight. Each person came to the laboratory on three separate days. On one day they sat for seven hours without a break. On another they sat for the same seven hours but got up every twenty minutes and walked slowly on a treadmill for two minutes. On the third they did the same with a brisker walk. On each day they were given a sugary, fatty test drink after the first two hours, and the researchers tracked their blood sugar and insulin for the next five.

On the day of unbroken sitting, blood sugar after the drink rose higher and stayed up longer. On the days with breaks, the rise in blood sugar over those five hours was about a quarter smaller, and the insulin response was lower by about the same amount. Insulin is the hormone your body releases to bring blood sugar down, and needing less of it to handle the same drink is a good sign. The slow walk did about as well as the brisk one.

I should be straight about the limits. It was nineteen people, all overweight, studied over single days in a laboratory. Nobody knows from this whether the effect persists over months, and the experiment can't tell you anything about heart attacks or lifespan. But it shows something the big surveys can't. Two minutes of easy movement changes what your body is doing with its blood sugar in the hours around it.

Why would something so slight have a measurable effect? This is the usual explanation, and I'm giving it in outline. Your biggest muscles are in your legs and backside. When you sit they're switched off almost completely, since the chair is doing their job. Working muscle takes sugar out of the blood, and idle muscle takes very little. Standing up and walking switches on the largest muscles you have, and even at a stroll that's a lot of tissue. The sensors and the blood tests pick up how long your large muscles were active, and those muscles are active whether you're walking to the kettle or training.

Think back to chapter 3. The body maintains what gets used. A day with fifteen or twenty short breaks in it asks your legs to work fifteen or twenty times. Each request is small, but a day with none of them looks quite different to your body, and that was the Wednesday in chapter 1.

You already know what a break feels like from the inside. When you stood at twenty to seven you were stiff. If you'd stood at six, and at half past, you wouldn't have been. The two-hour sit is what produced the stiffness, and it needs two unbroken hours to do it.

One piece of arithmetic is worth doing. Two minutes every half hour across a nine-hour working day comes to thirty-six minutes on your feet. Carry on through the evening and it passes fifty. Each break on its own is too short to feel like anything, but the total is a good part of the distance between three and a half thousand steps and six thousand.

"I can't keep getting up, I've got work to do"

The strongest practical objection comes from the working day, because that's where most of the tally is and where you have least control. You're paid to get things done. Getting up every half hour sounds like a way to get less done, to lose your thread twenty times a day, and to look as if you're avoiding work.

Take the worry about looking idle first, because I think it does more to keep people in their chairs than the work itself. In most offices, sitting still at a screen is what diligence looks like. It's worth noticing that it's only a look. You know from your own experience that an hour at the desk can contain twenty minutes of work, and that the answer to a problem often turns up on the walk to the kettle. Most colleagues, in any case, are paying far less attention to your movements than you imagine.

On whether breaks damage work, the best evidence I know is a large British trial. Charlotte Edwardson and colleagues worked with 756 desk-based council employees in Leicester, Liverpool and Greater Manchester. Whole offices were assigned by lot to one of three arrangements. Some got a programme to help them sit less, with coaching, prompts and small changes such as moving the bins and printers further away. Some got the same programme plus a desk that could be raised for standing. The rest carried on as usual. A year later the researchers measured everyone's sitting with sensors.

The programme alone cut sitting by about twenty-two minutes a day. The programme with the desk cut it by just over an hour a day. Both groups reported small improvements in stress, wellbeing and vigour compared with the offices that carried on as usual, and the desk group reported less pain in their legs and feet. The researchers measured work performance too. The published summary mentions no harm to it and no boost either, so I won't claim one.

So across dozens of real offices, people who sat an hour less each day felt somewhat better and their work didn't visibly suffer. That fits what most people find when they try it. A two-minute break at a natural pause costs you very little concentration. It can help, because long unbroken hours at a screen are when your attention goes soft, and you begin rereading the same paragraph.

The trick is to attach breaks to things the work already contains, so that they don't feel like interruptions. These are suggestions and you'll think of better ones for your own job.

Take phone calls standing up, and walk about if the lead or the signal allows. Many people think more clearly on their feet during a call anyway.

When you need to ask a colleague something, walk over and ask. It's often quicker than the exchange of messages would have been.

Use a smaller glass or mug. You'll refill it more often, and the refills will look after the other end of the process too.

Finish a task, stand up, then start the next one. The gap between tasks is a natural break, and you were going to lose a minute there regardless.

Use the furthest printer and the loo on the next floor, as the Edwardson programme arranged for people. It's the same errand, with forty more steps in it.

In a long meeting, say at the start that you'll stand at the back for part of it because it helps your back. Nobody minds, and often somebody else joins you.

And eat lunch somewhere other than your desk, even if it's only ten minutes on a bench. On the Wednesday in chapter 1, a walk to a bench and back would have been the only proper movement between half past eight and five.

Some jobs allow almost none of this, among them driving, call-centre work under a headset and a timer, and operating machinery from a seat. Chapter 15 deals with those. In that kind of job the breaks have to come at the edges of the working day, which makes the evening matter more.

"I'll buy a standing desk"

Once you've accepted that the sitting is a problem, the tempting next step is to buy something. A desk that goes up and down costs a few hundred pounds, arrives in a box, and looks like a solution. Some readers will have ordered one before finishing the last chapter.

It might help. In the Edwardson trial, the offices that got height-adjustable desks cut their sitting by about three times as much as the offices that got coaching alone. The desk made sitting less the easy option. It also acted as a reminder, because it's hard to forget you meant to stand when the handle is in front of you. If your employer offers one, take it.

But I'd like you to be clear about what the desk does, for two reasons.

The first is that standing isn't moving. Your legs do more when you stand than when you sit, because they're holding you up, and that's worth having. But someone who stands motionless at a raised desk for three hours has swapped one fixed position for another. People whose jobs keep them standing all day, such as shop staff and hairdressers, don't report that their legs and backs feel wonderful. Bodies do badly held in any one position for long. What helped in Dunstan's laboratory was walking for two minutes. If you get a desk, change position often, and walk to the kettle as before.

The second reason matters more to me, because it's about how these projects fail. Buying the desk feels like having dealt with the problem. There's a well-known way this goes. The desk arrives, you stand at it for most of the first week, your feet hurt, and by the second month it stays in the down position with a plant on it. Nothing's wrong with the desk. It was asked to do a job that only a habit can do.

So buy one if you want, but don't wait for it and don't let the purchase stand in for the change. Everything in this book can be done with the furniture you have. A worktop or a high shelf will hold a laptop for a twenty-minute standing spell. A phone call needs no desk at all. The break every half hour costs nothing and would be needed just as much if you owned the best desk in the catalogue.

The same goes for the other things sold to people with desk jobs. A better chair, a cushion, a footrest and a wrist support may each make sitting more comfortable. None of them is a bad thing to own. But a more comfortable chair is one you'll stay in for longer, and the length of the sit is what needs to change.

Watches and phones that buzz when you've been still for an hour are a partial exception, because they address the real difficulty, which is that you don't notice time passing in a chair. If you have one, switch the reminder on. If you haven't, a kitchen timer does the same job for a fiver, and chapter 14 suggests how to use it for the first couple of weeks.

The evening

By seven o'clock the working day's sitting is done, and you could argue that you've earned the sofa. You've been at it since half past eight. The evening is the only part of the day that belongs to you, and what you want to do with it is sit down and watch something.

I've no quarrel with that. An evening in front of the television with someone you like is one of the ordinary pleasures of life, and a book that told you to give it up would deserve to be ignored. What I'd like you to look at is the form the evening takes, because it's different from the working day in a way that matters.

At work, things interrupt you. The phone goes, someone wants you in another room, you need the printer. You get up more than you think, even on a bad day. The sofa has none of that. The remote is in reach, and so are your drink and your phone. One episode runs into the next without your needing to do anything. The evening sit is the longest and least broken of the day, and it comes after the day's largest meal. On the Wednesday in chapter 1 it ran from seven until half past ten with a single interruption, and that was somebody else's parcel.

That may be part of why television time came out worse than sitting in general in the big Ekelund study. Three hours or more a day in front of the television went with a higher death rate in all but the most active group. The researchers couldn't say why from their data, and I can't either. The reasons usually suggested are the ones I've just given, which are that it's unbroken, it follows dinner and it tends to come with snacks. It may also be that hours of

television stand in for other things, such as poor health or loneliness, that the studies couldn't fully measure. I'd hold the finding loosely. It does fit the laboratory result in chapter 8, where seven unbroken hours after a sugary drink was the worst condition.

Think back to Dunstan's test drink. His volunteers drank it and then sat, and their blood sugar ran high for hours unless they got up. Dinner followed by three hours of stillness is a home version of his worst condition.

The evening is also where the tired-so-rest loop from chapter 4 is tightest. You arrive home flat, the sofa takes you, and three and a half hours later you get up flatter. I don't think the television does that. Three and a half hours of any motionless activity would do the same.

So the change I'm suggesting for evenings is small. Keep the programmes and break the sit. Here are some ways to do it, from which you can pick.

Walk for ten minutes after dinner, before you sit down at all. Once you're on the sofa, getting up again is hard, so go while you're still on your feet from clearing the table. A walk after a meal also comes at the point in the day when your blood sugar is highest.

Get up between episodes. The gap is there, and the player fills it with a countdown precisely so that you won't use it. Stand, go to the kitchen, put something away and come back.

Leave the things you want out of reach. If your glass of water, your glasses case and your phone charger are in other rooms, the evening will contain several short walks that you didn't have to plan.

Do one job on your feet during the evening. Iron in front of the programme, or fold the washing at the worktop with the radio on. It counts for the purposes of this book, which may be the only good thing anyone has said about ironing.

And if you watch with someone, tell them what you're doing. Otherwise your getting up every half hour will look like restlessness or a comment on the programme.

If you're retired, the evening pattern may describe your whole day. The NHS figure of ten hours or more for the over-sixty-fives reflects the loss of those workplace interruptions. Without an office to make you get up, the prompts have to come from you. Everything in this chapter applies from nine in the morning.

What the chair costs you

So far I've talked mostly about risks measured in large studies. Those matter, but they're abstract, and nobody ever got off a sofa because of a hazard ratio. The costs you can feel are nearer to hand, and this chapter is about them.

The first is range. There's a list of things you do without thinking about them and another list of things you've quietly stopped doing, and items have been moving from the first list to the second for some years. You used to take the stairs at the multi-storey and now you take the lift. Getting down on the floor with Alfie used to be nothing, and now you weigh it up and sometimes stay on the sofa and direct operations from there. You'd have carried the heavy shopping from the far end of the car park, and now you circle for a nearer space. You didn't decide to give any of these up. Each time, the thing had become slightly uncomfortable, and an easier option was available.

Each item dropped removes some of the movement that was keeping you able to do it, which goes back to chapter 3. Take the lift for a year and the stairs get harder, which confirms that the lift was the right call. This is how a life narrows in middle age. Nothing dramatic happens. Small things are given up one at a time, and each seems sensible when it happens.

The second cost is energy, which chapter 4 covered. I'd add one thing. Low energy makes more than exercise unappealing. It takes the shine off the evening class you thought about, the walk with a friend on Sunday, the garden, and the weekend away that seems

like a lot of effort. People with a high tally often describe themselves as having become a homebody. Some of them have. Others are simply short of the energy that would make going out feel worth it.

The third is what the age story does to your expectations. If you believe at fifty-four that stiffness and tiredness are your age arriving, you'll expect more of both at sixty and plan accordingly. You'll choose the holiday with less walking and the bungalow over the house with stairs. Those are reasonable choices for someone in decline, and they help bring the decline about.

The fourth cost is further off and more serious, and I'll be brief about it because I don't want to frighten anyone. The strength you have at seventy-five and eighty decides some large things, such as whether you can get out of a chair without help, climb your own stairs, catch yourself when you trip, and stay in your own home. That strength is built or lost in the decades before. The NHS guidelines for older adults ask for activities that improve strength, balance and flexibility at least twice a week, for that reason. A thirteen-hour tally through your fifties and sixties draws down the reserve you'll need then.

A fair objection is that plenty of people sit all day and seem fine, and that your father sat in his armchair and lived to eighty-six. Both are true. These are averages and tendencies, and I can't tell you what will happen to you. But you can look at the costs in this chapter without any statistics, because you can see them in your own week. Ask which list the stairs are on, and the floor, and

whether you've begun planning around your body in ways you didn't five years ago. Those answers are about you in particular, and you can check them today.

The last cost is the noise itself. It's a small thing, but it matters. Every time you stand up with a grunt, you tell yourself a short story about getting old. You're hearing that story a dozen times a day, from yourself, and the argument of this book is that it's at least half wrong.

What comes back

If the stiffness and tiredness were age, there'd be nothing to discuss. The reason to separate out disuse is that it can be undone, and the evidence for that is better than you might expect.

Go back to the five men from Dallas. When the researchers found them again at fifty, they did more than measure them. They put them on a six-month training programme of walking, jogging and cycling, building up gradually. At the end of the six months they measured the men's maximal oxygen uptake again. It had risen by 14 per cent, which took it back to the level recorded before the bed rest in 1966. The researchers put it strikingly. One hundred per cent of the decline in aerobic power that had taken place over thirty years was reversed by six months of training.

There were limits, and the researchers reported those too. None of the men got back to the peak he'd reached at twenty after the hard training that followed the bed rest. Age had taken that peak away. What came back was the large, ordinary loss that three decades of desk life had laid on top.

It's five men again, so don't read the 100 per cent as a promise. Read it as a demonstration that the process can run backwards in a fifty-year-old.

It can run backwards a great deal later than that. Maria Fiatarone and colleagues ran a trial in a nursing home in the United States. The hundred residents who took part were frail, and their average age was eighty-seven. The oldest was ninety-eight. Half were given

progressive resistance training for their legs three times a week for ten weeks, which means exercises against a weight that was increased as they got stronger. Over those ten weeks the strength of the trained group more than doubled, with an average gain of 113 per cent. The untrained group gained 3 per cent. The trained residents walked faster and climbed stairs with more power. They also began moving about more of their own accord, the mirror image of what Kortebein saw after bed rest. Ninety-four of the hundred completed the study.

I find that study moving. The people in it were about as far along as a person gets, and their muscles still responded to being asked. If it works at eighty-seven in a nursing home, the mechanism hasn't switched off at fifty-four.

As for what you can expect for yourself, the studies I've described used proper training, and the rule in the next chapter is gentler than that, so I'll give you my expectations and label them as such.

Within the first week or two, the stiffness on standing should be noticeably less, for the plain reason given in chapter 5. You won't have been still long enough for it to build. This is the quickest return, and you can confirm it within a day.

Over the first few weeks, I'd expect the afternoon slump to soften and the evenings to feel less flat. That's going by Thayer's result, the larger reviews, and what people commonly report. Don't expect it to vanish. Sleep and food and the nature of your job all have a say in it.

Over a few months, I'd expect some items to move back from the second list to the first. The stairs will be less of an event. Getting up from the floor will need less furniture. These come back slowly, because rebuilding capacity takes longer than easing stiffness, and they'll come back faster if you add the strength work described at the end of the next chapter.

The breaks and the walk on their own won't make you fit, and they won't alter your weight or the shape of your body. I make no claim about either. Fitness takes training, as it did for the Dallas men. What the rule does is stop the daily instruction to your body that nothing will be required of it. If you then want to go further, you'll be starting from a better place, and with more energy to do it.

The decision

Here's the rule I'm suggesting.

I get up every half hour, and I walk for ten minutes every day.

It has six parts, and each one is there for a reason given earlier in the book.

Every half hour means every half hour of sitting. When you've been in a chair for thirty minutes, you stand up and move about for a minute or two. Walk to another room, climb a flight of stairs, fetch something, or just walk to the window and back. Then sit down again if you want to. I've chosen the half hour myself. Dunstan's experiment used twenty minutes, the NHS gives no figure, and nobody knows the ideal interval. Thirty minutes is frequent enough that a long sit can't build up, and it's easy to keep track of.

Use a timer for the first fortnight. You don't notice time passing in a chair, as the tally in chapter 1 showed. A kitchen timer, a phone alarm or a watch reminder will do it. Restart it each time you sit. After a couple of weeks most people find they've developed a rough internal sense of it, and the timer can go back in the drawer.

The break doesn't have to be exercise. It only needs to be upright and moving. Light movement did as well as brisk in Dunstan's laboratory. If a break happens to include the stairs taken fast, that's better still, and it's the kind of burst Stamatakis measured, but it isn't required.

The ten-minute walk is separate, and it's brisk. Brisk means you feel warmer and breathe a little faster, and you could talk but not sing, which is the NHS test for moderate activity. Do it whenever suits you. After lunch and after dinner are both good times, for the reasons in chapters 4 and 11. Ten minutes is a floor and you're welcome to go over it. If ten minutes of brisk walking is beyond you at the moment, walk at the pace you can manage and let it build.

Evenings and weekends count. The rule applies on the sofa as much as at the desk. Chapter 11 argued that the evening is where it matters most.

A missed break is just a missed break. You'll look up and find you've been sitting for an hour and a half. When that happens, stand up. Don't do extra to make up for it and don't write the day off. The rule is about what you do next.

Plans of the "when this happens, then I'll do that" kind make a decision much more likely to survive a busy day. Peter Gollwitzer and Paschal Sheeran pooled 94 tests of such plans and found that they made people a good deal more likely to follow through. Here are three, and you can change the wording to suit yourself.

When the timer goes and I'm in the middle of something, then I'll finish the sentence I'm on, stand up, and come back to it in two minutes.

When I put my knife and fork down after dinner, then I'll put my shoes on before I do anything else.

When an episode ends, then I'll stand up before the next one starts.

Tell the people you live and work with. It saves explaining yourself twenty times, and one or two of them may join you.

Once the rule has settled in, which I'd give a month, there's a natural next step, and I'd be leaving something out if I didn't mention it. The NHS asks adults of every age to do activities that strengthen the major muscles on at least two days a week. For the purposes of this book that matters because strength is what decides the stairs, the floor and the shopping, and it's what Fiatarone's residents rebuilt. It doesn't need a gym. The NHS website has strength routines that use your own body weight, and its list of strengthening activities includes carrying heavy shopping and heavy gardening. If you haven't done anything of the kind for years, this is the point at which the advice in the preface about talking to a GP applies most.

What to expect from the rule itself I've covered in chapter 13. The first few days may bring aches in your calves and hips, which is what happens when muscles that haven't been asked for much are asked for a little more. It should be mild and gone within the week. Pain that's sharp or that persists, or any of the warning signs in the preface, is a reason to stop and get advice.

Long drives, sore knees and other hard cases

If you drive for a living, or you have a long drive ahead. You can't stand up at the wheel. The Highway Code recommends a break of at least fifteen minutes after every two hours of driving, on grounds of tiredness. Use that break on your feet, walking round the services or the lay-by, and don't spend it sitting in a different seat with a coffee. If your working day is spent in a cab, the edges of the day carry the weight. Walk at the start and end of a shift, walk while you're waiting to load, and keep the evening rule in full.

If you work under a headset and a timer. Some jobs control when you can leave your seat. Stand for calls if the lead allows it, since standing still is better than sitting still. Use every scheduled break on your feet. It may be worth asking a manager or a union representative whether standing or sit-stand positions are available. Employers are more used to that request than they were.

Long meetings, trains, flights, the cinema and the theatre. Some long sits are part of life and worth having. Take them as they come and don't fret. Walk before and after, take an aisle seat when you can, get up when the seat-belt sign is off, and walk about in the interval. One unbroken three-hour sit in a week of good days doesn't matter much. The rule is aimed at the days when you hardly get up at all.

If you use a wheelchair or can't stand. The studies in this book measured sitting because for most people sitting means muscles at rest. What your body responds to is muscles working, and you can get that in a chair. The NHS publishes fitness advice for wheelchair

users and a set of sitting exercises, and the adult guidelines say they're suitable for disabled adults. The principle of this book carries over in a changed form. Break up long periods of stillness with a couple of minutes of whatever movement is available to you. A physiotherapist can help you work out what that should be.

If you have arthritis or painful joints. Chapter 5 quoted the NHS view that exercise is one of the most important treatments for osteoarthritis and usually helps to improve symptoms. Short, frequent, gentle movement is about the easiest form of it there is. Your GP or a physiotherapist can advise on what suits your joints. In many areas you can refer yourself to NHS musculoskeletal services without seeing a GP first. If a particular movement causes sharp pain, don't push through it, and ask for advice.

If you have ME, chronic fatigue syndrome or long Covid. I said in the preface that this book isn't written for you, and I'll repeat it here because well-meaning people may press it on you. The NHS says that graded exercise therapy, which aims to increase activity step by step, is not recommended for people with ME. Its guidance is built around managing your energy with support from professionals who know the condition. Please follow that guidance and not mine.

If you have a heart condition, high blood pressure, diabetes or another long-term condition. Gentle movement is recommended for most long-term conditions, but the details matter, and they depend on your medicines as well as your diagnosis. Ask your GP or specialist nurse. If you have diabetes and take insulin or certain tablets, more activity can lower your blood sugar, so ask how to allow for that.

If you feel dizzy when you stand up. Stand slowly, and pause for a moment before walking. If it happens often, mention it to a GP or pharmacist, because it's sometimes an effect of medication.

If you're pregnant. The NHS says its adult activity guidelines are suitable during pregnancy. Your midwife can advise on anything particular to you.

If you're ill, or it's one of those weeks. When you've got flu, rest. When work is frantic and the rule falls apart for three days, notice that and start again at the next half hour. Nothing is lost that a week won't put back. People who have been much more active can find that a stretch of stillness feels worse than it used to. That's a good sign, because it means your body has raised its expectations.

If the people around you think it's odd. For about a week they might. After that it's just a thing you do, like the colleague who always has a window open. Denise has been walking round the estate at lunchtime for years, and nobody thinks about it any more.

Wednesday again

It's a Wednesday evening some months on, and the doorbell goes at twenty to seven. You're not on the sofa. You got in at half past five, changed your shoes and walked round the block before dinner, which takes eleven minutes and has become the point at which the working day ends. Now you're standing at the worktop, slicing onions.

The day behind you looked much like the old one from the outside. It had the same drive and the same desk. But you took two calls on your feet, walked over to accounts with a question, and had your sandwich on the bench by the car park with Denise, who turns out to be good company. You stood at the back for the second half of the two o'clock meeting, and the head of department came and stood next to you. If you worked out the tally it would come to about ten and a half hours, which still sounds like a lot. But the longest sit of the day was forty minutes, and it used to be two and a half hours.

You walk to the door without noticing the walk, and that's what has changed. It's another parcel for next door.

Some things haven't changed, and I'd be misleading you if this chapter pretended otherwise. You're still fifty-four, and soon you'll be fifty-five. Your left knee is still the less reliable of the two. You're not an athlete and you haven't become one of those people. On Saturday you watched three episodes in a row, remembered at the end of the second, and got up then.

But the noise has gone. You didn't notice it stop. A few weeks ago you realised you hadn't heard it for a while. On Sunday you were down on the floor with Alfie and the train track, and when he ran off to find the bridge piece you got up and followed him, and only afterwards noticed that you hadn't reached for the coffee table. In the multi-storey last week you took the stairs because the lift was slow, and you were at the car before you'd thought about it.

The afternoons are better, though they aren't perfect. The slump still visits around three. Now you know what it is, and you walk to the far printer and back by the stairs, and by twenty past it's mostly lifted.

What pleases you most is harder to measure. The age story has lost its grip. You'd been reading every ache as a message about the years ahead, and it turned out that most of them were messages about the last two hours. You're still getting older, as everyone is. It's happening more slowly than you'd thought, and it's taking less from you than you'd assumed.

Here's one action, if you've read this far sitting down. Stand up. Walk to the furthest room of wherever you are, and back. Then set a timer for thirty minutes.

Notes

This book gives general information. It isn't medical advice, and it's no substitute for a professional who knows your situation. NHS guidance is quoted as I found it in September 2026 and applies to England.

I've kept sources out of the chapters where I could so they read easily. Here they are by chapter, with the limits I'm aware of. Unless I say otherwise, I read the published summary of each paper and not the full text. I checked each paper for a retraction or correction notice in September 2026. I found no retractions. The 2016 Lancet paper by Ekelund and colleagues has a published erratum, which I haven't read. Where a chapter isn't listed, it rests on my own reasoning. That includes chapters 1, 10 apart from one trial, 12 and 16. You at fifty-four, Alfie, Denise and every other example are invented for illustration.

Before you start. The advice to speak to a GP before exercising is from the NHS page "Physical activity guidelines for adults aged 19 to 64". The advice on when to see a GP about tiredness is from the NHS page "Tiredness and fatigue". The 999 criteria are from the NHS page "Chest pain".

Chapter 2. The figures of more than seven hours for adults and ten hours or more for people over sixty-five, and the account of how daily life lost its movement, are from the NHS page "Why we should sit less". The figure of 70 to 85 per cent of working hours is from the background section of Edwardson and colleagues, "A three arm cluster randomised controlled trial to test the

effectiveness and cost-effectiveness of the SMART Work & Life intervention for reducing daily sitting time in office workers: study protocol", BMC Public Health 18, 2018, article 1120. The list of reasons is mine.

Chapter 3. McGuire, Levine, Williamson, Snell, Blomqvist, Saltin and Mitchell, "A 30-year follow-up of the Dallas Bedrest and Training Study: I. Effect of age on the cardiovascular response to exercise", *Circulation* 104, 2001, pages 1350 to 1357. McGavock, Hastings, Snell, McGuire, Pacini, Levine and Mitchell, "A forty-year follow-up of the Dallas Bed Rest and Training study: the effect of age on the cardiovascular response to exercise in men", *Journals of Gerontology Series A* 64, 2009, pages 293 to 299. The 27 and 26 per cent figures are from the second paper. Kortebein, Symons, Ferrando, Paddon-Jones, Ronsen, Protas, Conger, Lombeida, Wolfe and Evans, "Functional impact of 10 days of bed rest in healthy older adults", *Journals of Gerontology Series A* 63, 2008, pages 1076 to 1081. Their scores on a standard test of everyday physical performance didn't change significantly, which I left out of the chapter for brevity. No study I know of has compared years of desk work with bed rest directly, so treating a sedentary day as a diluted form of bed rest is my inference. The account of the body maintaining what's used is a simplification of standard physiology.

Chapter 4. Thayer, "Energy, tiredness, and tension effects of a sugar snack versus moderate exercise", *Journal of Personality and Social Psychology* 52, 1987, pages 119 to 125. Eighteen volunteers took part over twelve days each. Puetz, O'Connor and Dishman, "Effects of chronic exercise on feelings of energy and fatigue: a quantitative synthesis", *Psychological Bulletin* 132, 2006, pages 866

to 876. The overall effect was 0.37 of a standard deviation, which is small to moderate, and as the chapter says, it disappeared in placebo-controlled trials of exercise alone. The idea that your sense of energy is a setting and not a gauge is my way of putting it.

Chapter 5. The description of why a still body feels stiff is a simplified outline and I haven't sourced it to a particular paper. The quotations on exercise and osteoarthritis are from the NHS page "Osteoarthritis, treatment". Roffey, Wai, Bishop, Kwon and Dagenais, "Causal assessment of occupational sitting and low back pain: results of a systematic review", Spine Journal 10, 2010, pages 252 to 261. The review covered sitting at work and found five high-quality studies. The warning signs for back pain are from the NHS page "Back pain", which lists more than I've given. The NHS page on rheumatoid arthritis says that the morning stiffness of osteoarthritis usually wears off within thirty minutes and that stiffness lasting longer can point to other kinds of arthritis.

Chapter 6. Ekelund, Steene-Johannessen, Brown, Fagerland, Owen, Powell, Bauman and Lee, "Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women", Lancet 388, 2016, pages 1302 to 1310. Thirteen studies with 1,005,791 people gave data on sitting, and six studies with 465,450 people gave data on television. The most active quarter reported more than 35.5 MET-hours a week, which the authors equate to about 60 to 75 minutes of moderate activity a day. The NHS quotation is from "Why we should sit less".

Chapter 7. Ekelund and nineteen colleagues, "Dose-response associations between accelerometry measured physical activity and sedentary time and all cause mortality: systematic review and harmonised meta-analysis", BMJ 366, 2019, article l4570. There were 36,383 people and 2,149 deaths over a median of 5.8 years. Paluch and the Steps for Health Collaborative, "Daily steps and all-cause mortality: a meta-analysis of 15 international cohorts", Lancet Public Health 7, 2022, pages e219 to e228. My estimate that the gap between the bottom two quarters is about twenty-five minutes of walking assumes roughly a hundred steps a minute. Stamatakis, Ahmadi, Gill, Thøgersen-Ntoumani, Gibala, Doherty and Hamer, "Association of wearable device-measured vigorous intermittent lifestyle physical activity with mortality", Nature Medicine 28, 2022, pages 2521 to 2529. The examples of what the bursts consisted of are mine, since the sensors record effort and not what people were doing. The NHS list of light activities is from "Physical activity guidelines for older adults".

Chapter 8. Dunstan, Kingwell, Larsen, Healy, Cerin, Hamilton, Shaw, Bertovic, Zimmet, Salmon and Owen, "Breaking up prolonged sitting reduces postprandial glucose and insulin responses", Diabetes Care 35, 2012, pages 976 to 983. The summary describes an initial two hours of sitting followed by five hours of measurement. The explanation in terms of large muscles taking up sugar is the standard one and isn't tested in this paper.

Chapter 9. Edwardson and fifteen colleagues, "Effectiveness of an intervention for reducing sitting time and improving health in office workers: three arm cluster randomised controlled trial", BMJ 378, 2022, article e069288. There were 78 office clusters. The

summary lists work performance among the outcomes measured and reports no finding on it in either direction. The list of ways to fit breaks into work is mine, apart from the moved bins and printers, which the trial's protocol mentions.

Chapter 10. Edwardson and colleagues as above. That people in standing jobs have their own aches is common observation, and I haven't sourced it.

Chapter 11. Ekelund and colleagues 2016 and Dunstan and colleagues 2012, as above. The possible reasons why television time looks worse than other sitting are suggestions made in this field generally and aren't established. The suggestions for the evening are mine.

Chapter 13. McGuire, Levine, Williamson, Snell, Blomqvist, Saltin and Mitchell, "A 30-year follow-up of the Dallas Bedrest and Training Study: II. Effect of age on cardiovascular adaptation to exercise training", *Circulation* 104, 2001, pages 1358 to 1366. The summary calls it a six-month endurance training programme. That it consisted of walking, jogging and cycling is from my memory of the full paper. Fiatarone, O'Neill, Ryan, Clements, Solares, Nelson, Roberts, Kehayias, Lipsitz and Evans, "Exercise training and nutritional supplementation for physical frailty in very elderly people", *New England Journal of Medicine* 330, 1994, pages 1769 to 1775. The trial also tested a nutritional supplement, which had no effect. That the training was for the legs, three times a week, and that the home was in the United States, are from memory and not from the summary. Everything under what to expect is my expectation and not a finding.

Chapter 14. The test for moderate activity and the advice on strengthening activities are from the NHS adult guidelines page. Gollwitzer and Sheeran, "Implementation intentions and goal achievement: a meta-analysis of effects and processes", *Advances in Experimental Social Psychology* 38, 2006, pages 69 to 119. The rule and its parts haven't been tested together. The half-hour interval is my choice.

Chapter 15. The driving advice is rule 91 of the Highway Code. The NHS pages used are "Fitness advice for wheelchair users", "Sitting exercises", "Osteoarthritis, treatment", "Back pain" for self-referral, and "Myalgic encephalomyelitis or chronic fatigue syndrome, treatment" for the statement on graded exercise therapy. I've extended that caution to long Covid on my own judgement, because many people with long Covid report the same worsening after exertion. The remarks on diabetes medicines and on dizziness are general advice, and your own clinician's view comes first.