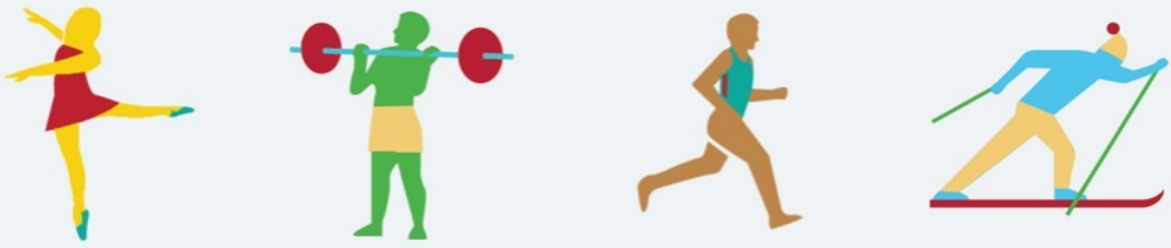
A PENGUIN SPECIAL

THE FIRST 20 MINUTES

PERSONAL TRAINER

THE RIGHT—AND THE WRONG—WORKOUTS FOR EVERYONE

GRETCHEN REYNOLDS



HUDSON STREET PRESS

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GRETCHEN REYNOLDS pens the “Phys Ed” column for the *New York Times*, which appears on the “Well blog online and in the Science Times print section. An award-winning journalist, her byline has appeared in the *New York Times Magazine*; *O, The Oprah Magazine*; *AARP Magazine*; *Popular Science*; and *Outside*, among others. She lives in Santa Fe, New Mexico.

Also by Gretchen Reynolds

The First 20 Minutes

The First 20 Minutes Personal Trainer

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A Penguin Special from Hudson Street Press

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HUDSON STREET PRESS
Published by the Penguin Group
Penguin Group (USA) Inc., 375 Hudson Street
New York, New York 10014, USA

USA / Canada / UK / Ireland / Australia / New Zealand / India / South Africa / China
Penguin Books Ltd, Registered Offices: 80 Strand, London WC2R 0RL, England
For more information about the Penguin Group visit penguin.com

First published by Hudson Street Press, a member of Penguin Group (USA) Inc., 2013

ISBN 978-1-101-63354-0

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Part I

Myth Information

So much of what we thought we knew about fitness is turning out to be wrong. Her are 15 common misconceptions and what science now says. Best news: no sit-ups!

Myth #1: You should always stretch before exercising.

In 2010, researchers at Florida State University asked ten male athletes to stretch for sixteen minutes then had them run for an hour on a treadmill. In a later session, the same crew sat quietly for sixteen minutes, and then hit the treadmill for the same duration. Without the pre-run stretch, the men covere significantly more distance while consuming less oxygen. The researchers' blunt conclusion: "Stretching should be avoided before endurance events."

Still, the pre-game ritual endures. Most of us were taught by our third grade PE teacher that you need a routine of static stretches—touching your toes and holding for thirty seconds—to be fast and flexible. Most physiologists now believe that when you elongate muscle cells, you cause a "neuromuscular inhibitory response," said Dr. Malachy McHugh, the director of research for the Nicholas Institute of Sports Medicine and Athletic Trauma at Lenox Hill Hospital in New York City and an expert on flexibility. By triggering a protective counterresponse in the nervous system, which tightens the muscle to prevent it from overstretching, you render yourself less powerful. In experiments, static stretching typically decreases strength in the stretched muscle by as much as 30 percent, an effect that can last for up to thirty minutes. That means basketball players who perform static stretches can't leap as high, and sprinters can't generate as much leg propulsion.

What's more, stretching does not seem to prevent injuries. In several large-scale studies of both athletes and military recruits (who march and run for hours), static stretching did not reduce the incidence of common overuse injuries such as Achilles tendinopathy or knee pain.

New Bottom Line

At best, you're probably wasting your time with stretching before exercise.

Instead, before your next race or workout, throw in the following five-minute "ballistic stretching" routine. Because these exercises don't stretch tissues to the point of activating the nervou system's protective instincts, they won't cause the negative effects of your old-school toe touches.

1. Jumping jacks (20 or so)
2. Skip forward and backward (for about a minute)

3. High-leg marches: Walk forward, kicking each leg up, knee straight, in front of you, like a tin soldier (for another minute or two)
4. Kick your own butt: Hop on one leg, kicking the other leg backward, touching your buttocks. (Aim for about 10 repetitions with each leg.)

Myth #2: Running ruins your knees.

Jog often, and well-meaning friends and meddlesome strangers will warn that you are going to ruin your knees. What they mean is that running will cause cartilage degeneration and arthritis, leaving yo with a limp and a large orthopedist's bill.

But science disagrees. A resonant 2011 review of the relevant research found that regular physical activity, especially running or playing sports, affected people's knees negatively at first glance: Active people had more bone spurs than the couch-bound, which would usually be considered an indication of knee dysfunction.

Yet those in the fit group also rarely suffered from joint-space narrowing, a condition that usuall accompanies bone spurs; it occurs when your knee's cushioning cartilage wears away and your bones begin closing in on one another, threatening to cause painful bone-on-bone arthritis.

In fact, in most of the studies that the scientists reviewed, active people had greater cartilage volume and were in less danger of developing arthritis than people who coddled their knees by not running or playing sports.

What the review's findings show, said study coauthor Dr. Flavia Cicuttini, a professor at Monash University in Australia, is that knees adjust to the forces created during activity, in part, it seems, by sprouting adaptive bone spurs. Overall, Dr. Cicuttini said, "physical activity is good for joints."

That conclusion received real-world confirmation via a wonderful study from Stanford University that followed middle-aged runners for nearly twenty years, by which time they'd become elderly runners. In the beginning, a few had creaky, mildly arthritic knees. (Interestingly, none of an age-matched control group of healthy non-runners did.) But after twenty years, only a few of the runners had noticeable arthritic changes in their knees joints, while 32 percent of the control group did, with 10 percent of them having developed severe arthritis versus less than 2 percent of the runners.

Similarly, a German study of middle-aged marathon runners found no deterioration within the racers' knees over the course of a decade, leading the researchers to speculate that "continuous exercise may be protective, rather than destructive," to knees, perhaps by stimulating cartilage cells t divide and rebuild the knees' cushioning. By the end of the Stanford study, the runners—now in their seventies and eighties—may no longer have been fast (if they'd ever been), but their knees were largely intact and they were all still running.

There is a substantial caveat to this good news, though: Vigorous physical activity, particularly running, seems to exacerbate damage if you have had a past knee injury, such as a torn anterior cruciate ligament (ACL) or meniscus (the pillows of cartilage that cushion the thigh bone and shin bone) or if you regularly have pain or swelling in your knee, especially after exercise, which can be a symptom of early arthritis. "Activity on an already diseased joint is what is bad for the knee," Dr. Cicuttini told me. By many estimates, more than half of all people who tear their ACL will develop

arthritis in that knee within ten or fifteen years, a process that might be hurried by the repetitive motion of running.

To slow the onslaught, most experts advise those with a history of knee injury to avoid weight-bearing activities, like running, as well as sports that involve side-cutting and sudden stops, including basketball and soccer. Instead, you might want to consider sports such as cycling or swimming (but avoid breaststroke, which stresses knees). If you take up cycling, have your bike correctly fitted. A study published last year concluded that a 5 percent difference in the height of a bike saddle could change the magnitude of forces applied to the knee by as much as 16 percent. The maximum angle of your knee during the pedal stroke shouldn't exceed thirty degrees, the study's authors write.

New Bottom Line

Healthy human knees are generally made healthier by running. If you currently run without knee pain then it's likely that you can continue without inducing arthritis. But talk to your doctor if you hear creaking, feel pain, and especially if you have a past history of knee injury, which can predispose your knee to instability and cartilage loss. And visit Part III, which details exercises designed to stabilize and protect the knee, advisable for anyone planning to still be using his or her original-equipment knee joint decades from now.

Myth #3: There's no such thing as too much exercise.

When exercise scientists in England recently scanned the hearts of retired English Olympians and of members of the elite 100 Marathon Club (entry to which requires exactly what the name suggests) and compared the scans to those from a group of active but not competitive older men, they were startled to see that the serious athletes were far more likely to have scarring in their heart muscle than the merely active group.

The question of how much exercise is necessary for health and fitness and how much is possibly too much remains open. A 2012 look by Johns Hopkins University researchers at all of the reported deaths occurring during or immediately after every known marathon race in the United States from 2000 to 2009 found that even as participation in marathon racing almost doubled during the past decade, to more than 473,000 finishers in 2009 from about 299,000 in 2000, only 28 people died, creating a vanishingly small risk of death, equivalent to less than one death per 100,000 racers.

"The findings reinforce what we really already knew," said Dr. Paul Thompson, the chief of cardiology at Hartford Hospital in Connecticut and longtime marathon runner, "which is that you are at slightly higher risk of suffering a heart attack during a marathon" than if you were merely sitting or walking sedately during those same hours. "But overall, running decreases the risk of heart disease" and therefore the likelihood of your suffering cardiac arrest at all. "In general, I'm less worried about people overindulging in exercise than in people not exercising at all," Dr. Thompson concluded.

Still, restraint seems wise. A Japanese experiment with mice, for instance, revealed that mild exercise, the equivalent of strolling for half an hour or so, boosted the animals' brainpower by increasing neurogenesis; but strenuous, prolonged running dampened the brain's response. When U.S. scientists made mice run for hours and then infected them with a virulent rodent flu, 70 percent died.

Half of a group of sedentary mice also succumbed. But mice that had jogged for about thirty minutes in the days before being infected almost all recovered.

New Bottom Line

In exercise, as in most things, moderation may be best.

Myth #4: Running barefoot is more natural and better for the body.

Shoes alter how we move. As soon as you put toddlers in cute little loafers, their walking changes: They take longer steps and land with more force on their heels. In the January 2010 issue of the journal *Nature*, Harvard scientists reported that urban schoolchildren in Kenya who wore shoes ran differently than unshod rural youngsters. Most of the urban children struck the ground with their heels, causing impact peaks, or shock waves, to travel up their legs. The barefoot runners landed lightly near the front of their feet.

A compelling finding, sure, but also meaningless for most of us. Unless you were raised in the bush, you grew up wearing shoes, and as repeated biomechanical studies show, our bodies cling stubbornly to what they know. When researchers from the University of Wisconsin–La Crosse outfitted recreational runners with lightweight, five-toed, barefoot-style running shoes, about half of the runners continued to strike the ground with their heels, just as they had in their old shoes. But if you hit with your heels and no longer have cushioning to dissipate the force, you amplify the poundin instead of reducing it.

"It's tough to relearn to run," the scientists cautioned in their report. Many of the volunteers in the study also reported blisters and bunions on their feet from the barefoot-style shoes.

Meanwhile, landing near the front of your foot, as many adept barefoot runners do, isn't an inju cure-all anyway. Biomechanics research shows that striking near the ball of your foot shoots shock waves up your leg, but in a different pattern from when you heel-strike. These forces move mostly through the leg's soft tissues instead of the bone, meaning less risk of a stress fracture—but more chance of an Achilles injury. In other words, your body takes a pounding from running, barefoot or not.

As for those oxymoronic five-toed "barefoot-style shoes," there is no scientific evidence that separating and individually encasing toes improves performance or has any other measurable functio although it does make donning the shoes arduous and gives the shoes what one commenter has called "feetier than feet" aesthetic. Also, unless you invest in five-toe socks, the footwear soon smells.

Regardless of whether you choose to run fully foot nude, though, or in lightweight barefoot-styl shoes, all experts agree that you must start slowly. And continue slowly. "Try five minutes of barefoo running at the end of your usual run," said Dr. Daniel Lieberman, a professor of anthropology at Harvard University and author of the *Nature* study. Gradually increase the barefoot distance by a quarter of a mile at the end of each run. And, above all, concentrate on form: Land lightly, don't overstride, and try not to pound the ground with your heel.

New Bottom Line

While going barefoot is fun and can be therapeutic for some runners, it's not for everybody. Whether to make the switch and throw out your shoes depends on your body type, discipline, history of injury, and how you feel about messing up a pedicure.

For some guidance about whether you should switch, check your past history of running-related injuries against this guide:

Injury: Sore knees
Go bare? Might be worth a try. Barefoot running has been found to lessen knee pain in some runners, since the pounding forces start to move up other parts of your leg.

Injury: Achilles tendon problems
Go bare? Probably not. Striking your forefoot increases stress on the Achilles. There is considerable anecdotal evidenced that novice barefoot runners strain their Achilles tendons.

Injury: Heel pain or plantar fasciitis
Go bare? Almost certainly a no. Without perfect form, you'll be pounding that sore heel even more than with shoes, but now you won't have any padding.

Injury: Sprained ankle
Go bare? Another maybe. It could be beneficial, after the ankle heals. Going shoeless seems to improve the body's proprioception, or spatial awareness, which could reduce the risk of another sprain.

Myth #5: Surgery is the best remedy for ACL tears.

A landmark study on torn ACLs published in 2010 in the *New England Journal of Medicine* kicked o heated disagreement about the effectiveness of going under the knife. Researchers randomly assigne either surgery or physical therapy to a group of 121 active adults who'd suffered an ACL tear. After two years, the groups' knees were similar in terms of function and pain, showing that there was little advantage to the surgery. Other studies have found that people are just as likely to eventually develop arthritis in their injured knee if they've had ACL surgery than if they did not have surgery.

New Bottom Line

It might be worthwhile to wait six months or so after an injury, to see how your knee heals. And watc the news. Scientists around the world are rapidly developing new techniques to repair damaged knees including growing new cartilage. Early results in mice are promising. But unless you want a mouse knee, you may need to wait a decade or so for the techniques to be fully available to us large primate

Myth #6: Exercise melts away the pounds.

Sadly, this isn't generally true. Many people lose little or no weight after starting an exercise progra and some gain, in part, no doubt, because as a 2012 review of decades' worth of studies related to exercise and weight loss concluded, human metabolism appears to be less revved by activity than wa once believed.

"There's this expectation that if you exercise, your metabolism won't drop as you lose weight o will even speed up," said Dr. Diana Thomas, a professor of mathematics at Montclair State Universit in New Jersey, who led the study.

But close mathematical scrutiny of all the past studies shows that that happy prospect is, by and large, unfounded. One of the few studies ever to have scrupulously monitored exercise, food intake, and metabolic rates found that volunteers' basal metabolic rates dropped as they lost weight, even though they exercised moderately every day. As a result, although they were burning up to five hundred calories during an exercise session, their total daily caloric burn was lower than it would hav been had their metabolism remained unchanged, and they lost less weight than had been expected.

The problem for those of us hoping to use exercise to slough off fat is that most current calculations about exercise and weight loss assume that metabolism remains unchanged or is revved by exercise.

So Dr. Thomas has helpfully begun to recalibrate weight-loss formulas, taking into account the drop in metabolism. Using her new formulas, she's working with a group of volunteers, providing them with improved predictions about how much weight they can expect to lose from exercise. These predictions, unlike most that you see in magazines and online, are proving accurate, she says, and although her forecast is for less weight loss than that under the old formula, the volunteers are pleased. "It's better to meet lower expectations," she says, "than to be disappointed that you're not losing what you supposedly should." (You can find a basic version of the revised weight loss calculator here.)

And there is some hopeful news on the exercise and weight-loss front. A few recent studies have shown that if you stick with the right kind of exercise, you may change how your body interacts with food. In one particularly appealing experiment, a group of women either ran or walked and, on alternate days, sat quietly for an hour and then were directed to an all-you-can-eat buffet.

Human appetite is complicated, driven by signals from the brain, gut, fat cells, glands, genes, an psyche. But certain appetite-related hormones, particularly ghrelin, which stimulates hunger, directly affect how much we consume. Exercise typically increases ghrelin. Workouts, in other words, make you hungry. And in this study, when the women ran, their ghrelin levels spiked, which should have meant they would attack the buffet with gusto. But they didn't. In fact, after running they consumed several hundred fewer calories than they burned.

Their restraint, the researchers found, was due to a simultaneous increase in hormones that initiate satiety. These hormones, only recently discovered, tell the body that it has taken in enough fuel; it can stop eating. The satiety hormones, the authors write, "muted" the message from ghrelin after the women ran.

On the other hand, walking did not increase satiety hormones, and the walkers overate, consuming more calories at the buffet than they had burned.

New Bottom Line

Exercise will not rev up your metabolism much. So if you want to lose weight, you'll need to consum fewer calories than you burn. Don't linger at the all-you-can-eat buffet after a workout. And if your main goal from exercise is to get thinner, consider running or other relatively vigorous types of exercise. They seem to better hone the body's satiety mechanisms than walking.

Myth #7: Stay ahead of your thirst!

In the 1990s, those of us running marathons were told to "stay ahead of your thirst" and to drink as much as we could stand during training and races, even if we sloshed as we strode. A decade later, almost everyone had been well schooled that drinking as much as possible can cause hyponatremia—essentially, intoxication caused by consuming too much water—a potentially fatal condition in which cells swell with the excess fluid.

Whether dehydration is equally troublesome and a hindrance to peak performance remains somewhat up in the air. But according to a 2011 review of time-trial studies of dehydration, losing up to 4 percent of body weight during exercise "does not alter" performance.

Results from endurance events do seem to bear that out: During the 2009 Mont Saint-Michel Marathon in France, researchers tracked the finishing time and weight loss of 643 competitors. The runners who lost the most water weight were also fastest. Most of those who finished in less than thre hours lost at least 3 percent of their body weight to sweat.

New Bottom Line

Drinking too much is probably unhealthier and more detrimental than dehydration is likely to be for most of us. "Drink when you feel thirsty," said Dr. James Winger, assistant professor at Loyola University's Stritch School of Medicine in Chicago, who conducted a survey of distance runners last year and found that misconceptions about hydration were rampant, even among endurance athletes. "Thirst is an exquisitely finely tuned indicator of your body's actual hydration status," Dr. Winger said. "Listen to it."

Myth #8: Fructose is evil.

The warnings are stern: Avoid fructose, especially in the form of high-fructose corn syrup, because it's contributing to an obesity epidemic. And the evidence is strong that people who are sedentary should avoid it. But if you're physically active, especially if you exercise for more than forty-five minutes or so at a time, the situation is different. "People who exercise or compete for more than forty-five to sixty minutes need to replenish their body's fuel with carbohydrates"—i.e. sugar, said D Luc van Loon, a professor at Maastricht University Medical Center in the Netherlands, who's long studies sports nutrition. And you'll get more benefit if that sugar is, in part, fructose. When cyclists i a British study drank a beverage containing both fructose and glucose (a simple sugar that typically appears on labels as maltodextrin), they rode almost 8 percent faster during a time trial than riders

who drank fluids with glucose alone. “Fructose and glucose are taken up in the intestine by different transport proteins,” Dr. van Loon said. “This allows for a more rapid uptake of carbohydrates from th gut.” Which means you have more calories available to you more quickly if you drink or eat carbohydrates containing fructose.

Also, although fructose is also partially metabolized in the liver and has been linked to a dangerous condition known as fatty-liver disease in inactive people, this is not the case among peopl who work out. “Physically active people burn through the fructose before it can contribute” to fatty liver disease, said Dr. Asker Jeukendrup, a professor of exercise metabolism at the University of Birmingham in England, who led the study of cyclists.

Most high-fructose corn syrup contains approximately equal portions of glucose and fructose an is perfectly acceptable for athletes. Ultimately, the concerns about high-fructose corn syrup have at least as much to do with the highly processed foods they often show up in than with the intrinsic characteristics of the sugar.

The drawback for active people is that the scientifically ideal ratio of glucose to fructose is 2:1, not the 1:1 of high-fructose corn syrups. “There are very few drinks on the market that provide that perfect mix,” Dr. Jeukendrup said. “But there are some.”

New Bottom Line

Read labels. Some sports drinks now tout their 2:1 glucose-fructose mix, citing the latest science.

For do-it-yourselfers, sports nutritionist Nancy Clark’s homemade sports drink, from the fourth edition of her *Sports Nutrition Guidebook*, features a nice blend of table sugar and fructose, which is, after all, what sweetens fruit.

¼ cup sugar
¼ teaspoon salt
¼ cup orange juice
¼ cup hot water
3½ cups cold water
2 tablespoons lemon juice

In a quart pitcher, dissolve the sugar and salt in ¼ cup hot water. Add the orange and lemon juice and 3½ cups cold water.

Myth #9: Sit-ups will give you abs of steel. And you want abs of steel.

First of all, six-pack abs prove only that someone has given too many hours to the gym and too little attention to keeping his shirt on. “There is no functional benefit to rippling, six-pack ab muscles,” sa Dr. Thomas Nesser, a professor at Indiana State University, who’s extensively studied the effects of exercising the core.

More to the point, it’s unclear whether specifically “working the core,” as so many gym classes and trainers exhort you to do, is necessary or advisable. Specific core-training programs don’t seem,

surprisingly, to make people better athletes. In a representative recent study, collegiate rowers who added an arduous eight-week regimen of core exercises to their regular rowing workouts wound up with stronger, tauter cores. But they didn't become better rowers: Their performances remained the same. Similarly, researchers at Indiana State University measured core strength among a group of Division I varsity football players and then had them complete performance drills like shuttle runs. The researchers found almost no correlation between a supercharged core and athletic performance.

What's more, the sit-up, that ubiquitous exercise that promises a midsection like the Situation's is often harmful, placing devastating loads on spinal disks, said Dr. Stuart McGill, a professor of spin biomechanics at the University of Waterloo and one of the world's experts on the back. When he and his colleagues simulated sit-up exercises using spines from pig cadavers, the spinal disks usually ruptured after a few hundred reps. "Sit-ups are totally unnecessary and probably counterproductive," Dr. Nesser said. Yay.

New Bottom Line

Core strength, as measured by the tightness of your abdominal muscles, is overrated, and you risk injury by focusing too specifically on it. You do need some basic core strength and stability, to prote your back and allow you to lead a productive life. Otherwise, you can't lift a load of laundry or complete a tennis swing. For basic exercises to stabilize your spine, see Part III. And take heart, fellow sit-up haters: New studies show that running—long thought to provide little or no core strengthening—does work your midsection. "Train for your sport and core strength will develop," Dr Nesser said.

Myth #10: Popping ibuprofen before a hard workout prevents sore muscles afterward.

Shorts? Check. Shoes? Check. Advil? Check. "Vitamin I" has become a pre-race routine for many athletes. In surveys, up to 70 percent of distance runners and other endurance athletes report that they down the pills before every workout or competition, viewing the drug as a preemptive strike against muscle soreness. At the 2006 Western States 100 ultra-endurance marathon, seven out of ten racers polled said that they had swallowed painkillers before the race, while almost 60 percent of racers at the 2008 Ironman Brazil said that they would pop ibuprofen before, during, and after the event. "It's become part of the ritual of getting ready to workout or compete," said Dr. Stuart Warden, the direct of the Musculoskeletal Research Laboratory at Indiana University, and an expert on the physiologica impacts of the drugs.

After the Western States race, however, those competitors who'd used ibuprofen were just as so as those who hadn't. They also, surprisingly, displayed more blood markers of inflammation than other competitors, even though ibuprofen is an anti-inflammatory.

Recent work from Dr. Warden and others has suggested that frequent use of painkillers also can blunt the ability of muscles to adapt to exercise. In a study of distance-running mice, researchers determined that "ibuprofen administration during endurance training cancels running-distance-dependent adaptations in skeletal muscle." In other words, the rodents' muscles stopped growing

stronger.

More graphically, Dutch cyclists who rode hard for an hour immediately after swallowing the recommended adult dosage of ibuprofen soon showed markers of gastrointestinal leakage into their bloodstream. Their intestines were becoming porous. The health implications of that finding aren't clear, the researchers wrote, but are certainly disagreeable. It could turn out that if someone uses ibuprofen before every exercise session for a year or more, one of the study's authors told me, "intestinal integrity might be compromised," and small amounts of bacteria and digestive enzymes could leak regularly into the bloodstream.

New Bottom Line

As Dr. Warden wrote in a recent editorial, it's increasingly likely that "ritual use" of ibuprofen and similar painkillers "represents misuse." So avoid taking ibuprofen unless you have a legitimate injur "Painkillers are quite effective at combating acute pain," Dr. Warden said, "but not at preventing it." As far as muscle pain goes: welcome it, at least to a degree. It's part of the training response, and nothing has been shown to effectively combat it, really.

Myth #11: You should ice sore muscles.

Icing aching muscles can feel good. But scientists are raising doubts about whether the practice does good. A telling, if goofy, study from several years ago found that people who sat in an ice bath after hopping on one leg until exhaustion had just as much pain and swelling the next day in their pogoing leg as a separate control group that sat quietly after hopping. In fact, the ice bathers reported more pain than the control group during a test in which they rose out of a chair using their tired leg for support. "The protocol of ice-water immersion" in the study "was ineffectual" in reducing pain or restoring function to the hoppers' sore legs, the authors concluded.

Other researchers have shown that icing sore muscles may temporarily numb pain, but it also lessens inflammation—a process that may be necessary to induce robust healing.

New Bottom Line

Save the ice for your Diet Coke. It doesn't seem likely to speed muscle recovery.

Myth #12: Guzzling bananas and electrolytes will prevent muscle cramps.

For years, we've heard that exercise-induced cramping is caused by dehydration and an accompanyin loss of sodium and potassium. Sufferers have been urged to load up on bananas or chug salty sports drinks before working out. That theory no longer holds water. For a study published in 2011, South

African researchers recruited hundreds of Ironman racers, a group frequently felled by muscle cramp Just prior to the events' starts, researchers took blood samples to test for levels of sodium and other electrolytes in the athletes, and then drew blood again at the finish lines. They also checked racers fo signs of clinical dehydration. Forty-three of the Ironmen had cramped during the race, but the afflicte were no more dehydrated than the other competitors, and shared comparable electrolyte levels with them. The principal difference between the two groups was speed: The stricken were faster.

When another team of scientists examined the issue in North Dakota, they reached similar conclusions. After asking a group of young, fit men to top up with sports drinks and then ride stationary bicycles, the researchers had little trouble inducing their muscles to cramp. Since the rider were adequately hydrated, the spasms "were likely not caused by dehydration," said Dr. Kevin C. Miller, a professor at North Dakota State University in Fargo, who led the study. Instead, he believes that muscle cramps are due to intense exertion, fatigue, and a cascade of accompanying biochemical processes that all go hand in hand with, say, setting a new personal record.

New Bottom Line

Water and electrolytes have little do with your muscles seizing up. Dr. Miller still can't tell you how to eliminate cramps altogether, but in another of his recent studies, cyclists experiencing cramps who drank 2.5 ounces of pickle juice recovered 45 percent faster than those who drank nothing. Something in the acidic juice seems to disrupt the nervous-system melee in the exhausted muscle.

Myth #13: Everyone responds to exercise the same way.

Recently, researchers in Finland, a nation not known for sloth, enrolled 175 sedentary adults in an exercise program. Some lifted weights. Others jogged. Some did both. After 21 weeks, many had gained endurance. Some were stronger. Very few had achieved both. But there were, the scientists noted dryly, "large individual differences in the responses to both endurance and strength training," and quite a few had lost strength and/or endurance, by as much as 8 percent.

It's not fair, but some people don't achieve the same results from the same exercise program as their friends and training partners. Genetics seems to be to blame. For a large-scale study published last year, geneticists at Pennington Biomedical Research Center in Baton Rouge, Louisiana, combed the DNA of 473 healthy volunteers who'd completed an endurance-training program, during which some had gained endurance and some hadn't. The researchers found 21 snippets of DNA in the so-called nonresponders that were different from those who'd gotten fit.

This finding doesn't give us carte blanche to skip exercise, said Dr. Claude Bouchard, a professo of genetics at Pennington, who led the gene study. "There are benefits to exercise that can't be measured" by whether you can run three miles without huffing or dead lift your body weight, he said "But it may be that some people's genetic profiles make them better suited" to certain kinds of exercise, he said. Tests to determine whether and how you'll respond to workouts are years away, however.

New Bottom Line

Blame your genes if you're not getting as fit or strong as your gym buddies. But go to the gym anyway.

Myth #14: Aging is aging.

Twins are useful for looking at how lives diverge and why (the old genetics/lifestyle continuum), which recently prompted researchers at King's College London to contact more than 24,000 pairs of British twins—some identical, some fraternal—and ask about their exercise habits and for blood samples. The scientists then studied the state of the twins' telomeres, or tiny caps on the ends of DNA strands in their cells. Telomeres help to keep DNA intact during cell division, and it's widely accepte that longer telomeres mean healthier, younger cells. Among the twins, more activity meant longer telomeres, even among identical twins, suggesting that exercise, as the scientists wrote in their study makes people "biologically younger."

Their findings join a chorus of good news about the malleability of aging, suggesting that "many of the physical effects we once thought were caused by aging are actually the result of inactivity," sa Dr. Hirofumi Tanaka, a professor of physiology at the University of Texas at Austin. Take sarcopenia or shriveling of muscle mass with age. It's common but not inevitable, it appears. A recent experime at the Canadian Centre for Activity and Aging reported that the leg muscles of aging runners were packed with motor units, a marker of muscle health. Elderly athletes had as many motor units in thei legs as did twenty-five-year-olds, meaning, the Canadian scientists write, that working out may "mitigate the loss of motor units with aging well into the seventh decade of life."

New Bottom Line

You can reset your biological age by staying in motion.

Myth #15: You can't make new brain cells.

You, like me, were probably taught in high school biology class that people are born with a certain number of brain cells and will never have more. Deplete your supply with a regrettable overindulgence in beer, or just by aging, and your mental function, we were told, will wilt.

But a groundbreaking discovery in the late 1990s changed how we think about thinking. Scientists studying cancer injected willing patients with a compound that marks newborn cells. After some of the patients died, researchers performed autopsies and found, to their astonishment, marked cells in the people's brains. Their brains contained new neurons.

Since then, scientists have confirmed that neurogenesis (the term for the making of new brain cells) occurs in everyone and "continues throughout a person's lifetime," said Dr. Justin Rhodes, an associate professor of psychology and neuroscience at the University of Illinois. Most neurogenesis takes place in the hippocampus, the brain's central processing center for memory and many types of learning.

Sadly, neurogenesis rates slip with age. But you can stem the decline by visiting the gym. In wo
from Dr. Rhodes's lab and others, young and middle-aged mice that ran on wheels for a few weeks
wound up with twice as many newborn brain cells as sedentary animals. The runners also aced tests o
rodent IQ.

New Bottom Line

You produce new brain cells throughout your life. Use them well.

Part II

Fitting Fitness into Your Schedule

How to slip a workout into the next . . .

. . . Two Minutes

Stand up.

You're probably sitting and reading this section right now, aren't you? Well, stop it. Rise. There are few easier, speedier ways to enhance health and fitness than simply to stand up often and move for at least two minutes before reseating yourself. Prolonged inactivity—i.e. sitting—otherwise can silently and insidiously increase your risk of heart disease, diabetes, and weight gain, even if you regularly en your workday at the gym. In recent experiments, lab rats had tiny casts placed on their back legs to enforce sloth, simulating the kind of immobility that we humans achieve so easily during hours spent in front of a computer or television.

After as little as two days, the animals developed noxious cellular changes throughout their bodies, and not merely in the immobilized muscles. In particular, they produced substantially less of an enzyme that dissolves fat in the bloodstream. As a result, fat accumulated, eventually migrating to the animals' hearts and livers, jump-starting rodent versions of heart disease and diabetes.

The same unpleasant dynamic occurs in unmoving people and just as rapidly. In a noteworthy experiment at the University of Massachusetts, healthy young men were asked to don a clunky platform shoe with a four-inch heel on their right foot, leaving the left leg to dangle above the ground. For two days, the men hopped about using crutches (and presumably gained some respect for their distaff cousins who regularly toddle about in platform heels). Each man's left leg never touched the ground. Its muscles didn't contract. It was fully sedentary.

After two days, the scientists biopsied muscles in both legs and found that the biological environments there were now very different. The right leg was normal. But in the sedentary left leg, insulin response was dropping, oxidative stress was rising, and metabolic activity within individual muscle cells was slowing, while genetic mechanisms that help to repair DNA were disrupted. Essentially, these healthy young men now had the left leg of some tired, aging, sedentary other self.

And many of us impose those same physiological conditions on ourselves every day. By most estimates, American adults sit, unmoving, for eight to ten hours every day. We sit in the car or on the train to commute to work. We are deskbound at work. Then we cement ourselves to the couch in the evening to watch television.

And we are harming ourselves in the process. One of the most chilling statistics to have emerged

from exercise science in the past few years is this: Every hour of uninterrupted sitting after the age o forty could potentially snip twenty-two minutes from someone's life, even if he or she occasionally exercises.

Thankfully, it's simple to undo that kind of damage. Stand up. Move around. For a heartening experiment published in 2012, scientists in Melbourne, Australia, had nineteen adults sit completely still for seven hours or, on a separate day, rise every twenty minutes and walk around for two minute When the volunteers remained stationary for the full seven hours, their blood sugar spiked and insuli levels were out of whack. But when they broke up the hours with a leisurely two-minute stroll around the laboratory, their blood sugar levels remained stable.

The Takeaway

Every twenty minutes throughout the day, stand up and move for at least two minutes. This two-minute threshold does seem to be the minimum amount needed to combat the damaging effects of sitting, a variety of studies have found. But how you move for those two minutes is up to you. Like Ping-Pong? When a company in Minneapolis installed a table, as part of a larger Mayo Clinic experiment, eighteen employees began using it during regular breaks. After six months, they'd lost weight, reduced their collective blood pressure, and improved their cholesterol profiles.

Other options: Stride up and down the hallway, skimming paperwork if you can't tear yourself from that spreadsheet. Then, FYI, complete your expense report immediately afterward. Multiple studies have found that even a brief walk will typically improve people's ability to perform mathematical calculations, apparently by improving blood and oxygen flow to the brain.

Also, invest in telephone headsets so that you can easily stroll around your office while making phone calls. Gesticulate while speaking; fidgeting has been shown to burn substantial numbers of calories. Do a few jumping jacks, which tone lower-body muscles and waken anyone slumbering on the floor below you. Walk to the window. Bob around to inner music or, if you require a soundtrack, the playlist on your phone or computer

And don't surrender to the call of the couch in the evening. In one study, when volunteers walke in place during every commercial break in an hour-long drama—with most of the breaks lasting for the desirable two minutes—the volunteers accumulated an easy twenty-five extra minutes of exercis and, well down the road, perhaps twenty-two extra minutes of life.

. . . 10 Minutes

Go for a walk.

That may seem like too little exertion to have a meaningful effect. But for many of us, especially those who haven't been exercising much, it's an excellent start. According to an inspiring 2012 study of more than 650,000 adults, those who walked for ten minutes a day, even if they got no other exercise and even if they were overweight, lived on average about two years longer than those who couldn't carve out those ten minutes. "The implications are obvious," the study's coauthor, Dr. Steve Moore, a researcher the National Cancer Institute, told me. "If you currently do no leisure-time

physical activity, adding just ten minutes of exercise per day may result in a notable increase in life expectancy."

Ten minutes can also be the start of more-ambitious but achievable exercise routines.

"Every January or during the Olympics or other big athletic events, people get excited to exercise, to get in shape," Dr. Glenn Gaesser, a professor and director of the Healthy Lifestyles Research Center at Arizona State University told me recently. The streets and gyms fill with people who are fueled by New Year's resolutions or an aching desire to resemble the physiques of Lolo Jone or Ryan Lochte. But "within a few weeks, most people quit," Dr. Gaesser said.

So he and his colleagues recently set out to see how little exercise people could do and still benefit, at least in terms of improving their health. "We wanted to see if there were approaches to exercise that would fit more easily into people's lifestyles, but still be effective," he explained.

Specifically, he and his colleagues wanted to determine whether breaking up exercise into manageable segments performed throughout the day would work as well as one longer, continuous, and more-daunting bout. So they gathered sedentary adults who were healthy, except that they suffered from prehypertension, an early stage of high blood pressure and a primary risk factor for heart disease and stroke. Prehypertension is known to respond well to moderate exercise sessions lasting for at least thirty minutes.

But, sadly, few Americans actually exercise for thirty minutes at a stretch, no matter what their best intentions. According to surveys, fewer than a third of us work out for at least thirty minutes several times a week, and that estimate is actually almost certainly too high. When researchers strap high-tech pedometers onto large numbers of people and track how active they actually were, barely 1 percent on average walk or otherwise exercise for at least thirty minutes a day.

Bowing to that reality, Dr. Gaesser asked his volunteers to walk briskly for only ten minutes at a time. But he asked them to repeat the exercise twice more during the day, for a total of thirty minutes The sessions took place in the morning, early afternoon, and evening. On another day, the volunteers completed one uninterrupted thirty-minute walk, and on another day, they didn't exercise. They wore blood-pressure monitors throughout.

As it turned out, breaking up the workout into three ten-minute sessions was more effective than the single half-hour session at controlling blood pressure, which was "really encouraging," Dr. Gaesser said. "For people who think that thirty minutes of exercise is too hard or takes up too much time, we can say, just do ten minutes" three times.

Other studies have found similar health benefits for short, repeated blocks of physical activity. Older women in one study who walked for ten minutes several times during the day lost more weight than those who walked once for thirty minutes. Ditto in a group of children in Europe, who gained les weight over the course of several months if they ran and tumbled about with friends for five – to ten-minute spurts of time, rather than during one longer, fixed, daily exercise session. A few small studie have even found that out-of-shape people improved their endurance more quickly when they exercise for ten minutes several times during the day rather than in one thirty-minute session.

But chunking your workouts does have limitations, especially for the already fit. "You're not going to be able to run a marathon or make it to the Olympics" based on three ten-minute walks a day Dr. Gaesser said. "You'll be healthier. You won't be an athlete."

The Takeaway

If you haven't been exercising at all, start now by walking ten minutes. As that becomes easy, add

another ten-minute session and then a third. The science seems clear that you can get the same or greater health benefits as from one thirty-minute workout.

Meanwhile, even briefer bouts may turn out to be worthwhile for preventing heart disease and otherwise improving health. Dr. Gaesser and his colleagues currently are studying whether a mere tw minutes of walking repeated 15 times during the day can effectively reduce blood pressure. Subtextually, of course, that experiment may reveal more about American attitudes toward physical activity than we might wish. Still, Dr. Gaesser told me recently, early results are promising.

. . . 20 Minutes

HIIT the gym or your local running trail or pool.

A ten-minute walk is a fine and pleasurable thing. But if your exercise goal is to increase endurance and eventually stomp on your beloved spouse's ego at your next shared Fun Run, then strolls will not be sufficient. To increase aerobic fitness and speed, you must exercise intensively. You can do so wit duration, running, or cycling for an uninterrupted hour or more. But that time commitment, especiall with the corollary time needed to reach the gym or trail, warm up, cool down, shower, nap, and so on is daunting for many of us.

So thank goodness for the Canadians, an obliging group of whose scientists has devised a better way. Their work with high-intensity interval training, familiarly known as HIIT, suggests that we can telescope about two hours' worth of high-quality endurance training into a mere twenty minutes.

Most of us who exercise or read books on the topic have heard of intervals, those repeated, short sharp bursts of strenuous activity, interspersed with rest periods. Almost all competitive athletes strategically employ a session or two of interval training every week to improve their speed and endurance.

But researchers at McMaster University in Ontario, Canada, have been studying whether interva can serve as a person's sole form of exercise. "There was a time when the scientific literature suggested that the only way to achieve endurance was through endurance-type activities," such as lon runs or bike rides, Dr. Martin Gibala, chairman of the Department of Kinesiology at McMaster, told me.

But work at Dr. Gibala's laboratory has upended that idea, potentially freeing plenty of time in our schedules. In the group's most famous experiment, which was the most-read and most-downloaded study from the website of the *Journal of Applied Physiology* for a year, the researchers asked healthy, male college students to vigorously ride a stationary for two hours, while a second group of volunteers completed a series of very short, strenuous intervals: twenty to thirty seconds of cycling at the absolute maximum intensity the riders could stand. After resting for four minutes, thes students pedaled hard again for another twenty to thirty seconds, repeating the sequence four to six times (depending on how much each could stand), "for a total of two to three minutes of very intense exercise per training session," Dr. Gibala said. Each group performed the same routine three times a week, for a grand total of about six hours of exercise for the endurance riders and six minutes for the interval trainers.

After six weeks, though, their results were almost identical. The endurance riders had developed

sturdier leg muscles, stronger lungs, and changes within their muscle cells that enable them to use fu and create energy more efficiently. They'd also dropped body fat.

The interval riders had developed the same changes, despite completing about 90 percent less exercise. They had even lost weight, although they were working out for only six minutes at a time.

There's a catch, though, as you might have guessed. Those six minutes, to be effective, have to b quite unpleasant, "an 'all-out' effort," Dr. Gibala said.

Recognizing that most of us would shrink from such lacerating discomfort, Dr. Gibala and his colleagues have now developed a gentler but still abbreviated approach to HIIT. This routine involve one minute of strenuous effort at about 90 percent of a person's maximum heart rate (which men can estimate, very roughly, by subtracting their age from 220; for women, the formula is 206 minus 88 percent of her age), followed by one minute of easy recovery. The effort and recovery are repeated te times, for a grand total of twenty minutes.

They've now tested this approach on healthy collegians; unfit, middle-aged adults; and even cardiac rehabilitation patients. After three weeks of twenty-minute workouts performed three times per week, almost all of the volunteers in each of the groups had improved their endurance and the strength of their hearts to the same extent as if they had been exercising for six hours or so at a lower intensity.

Obviously consult a doctor before beginning any exercise program, especially if you have been sedentary to this point.

The Takeaway

First, pick your preferred form of exercise. Although Dr. Gibala's research was done in a lab with stationary bicycles, neither is necessary to HIIT on your own. Other scientists have shown that twenty minutes of running or swimming can be equally effective. Even walking works, according to a Japanese study of sedentary elderly Japanese. They walked hard for one minute and easy for the next and after several months, had gained endurance, lost weight, and improved their cholesterol profiles and blood pressure.

The structure of the sessions is easy. Warm up briefly by pedaling, jogging, or stroking gently fo a minute or two. Then push yourself hard for one minute, ease off for one minute, and repeat that sequence ten times.

A heart-rate monitor, complicated heart-rate percentage calculations, and math degree are not required. "You can use your own sense of how hard you're working," Dr. Gibala said. "Just be honest." The one-minute intervals should feel like at least an 8 and preferably a 9 on an unpleasantness scale of 1 to 10, he said. The rest intervals should feel like about a 3.

"One good thing about HIIT is that it is completely customizable," Dr. Gibala said. "You exerci at a percentage of your maximum heart rate and power," which for someone who has been sedentary or sick will be low to start. But "that's fine," Dr. Gibala said.

Even better, most people who take up HIIT report enjoying it more than standard, prolonged exercise sessions, probably because, as one researcher explained succinctly, "the hard work is so short." In Dr. Gibala's lab, volunteers assigned to the long, slow workouts often request a shift to the HIIT group, because, he said, "they see those guys finishing up and heading home" and wish that they were, too.