Healthy Mind, Healthy Body: Benefits of Exercise

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Harvard Medical School
77 Avenue Louis Pasteur
Boston, MA 02115

THE Longwood SEMINARS
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Healthy Mind, Healthy Body: Benefits of Exercise

Moderator

Myechia Minter-Jordan, MD, MBA
President and CEO of The Dimock Center
Clinical Instructor in Medicine, Harvard Medical School
Faculty Director for the Abundance Agents of Change Program, Center for Primary Care, Harvard Medical School

Speakers

Irene S. Davis, PhD, PT, FAPTA, FACSM, FASB
Director, Spaulding National Running Center
Professor, Department of Physical Medicine and Rehabilitation, Harvard Medical School

Zolt Arany MD, PhD
Associate Professor Medicine, Cardiovascular Institute,
Beth Israel Deaconess Medical Center
Harvard Medical School

About the Speakers

Myechia Minter-Jordan, MD, MBA

Myechia Minter-Jordan is president & CEO of The Dimock Center, a community institution serving Boston's Roxbury, Dorchester and Jamaica Plain neighborhoods. As the second largest health center in Boston, Dimock is considered a national model of comprehensive health and human services with an emphasis on the integration of clinical and behavioral health practices.

Dr. Jordan earned both her undergraduate and medical degrees from Brown University. After graduation, she joined Johns Hopkins first as an attending physician and instructor of medicine at Johns Hopkins Medical Center and subsequently as director of medical consultation services at Johns Hopkins Bayview Medical Center.

Coming from a family that stressed the value of giving back, in 2007 Dr. Jordan was inspired to leave a successful career in academic medicine to lead the Dimock Community Health Center. As chief medical officer, Dr. Jordan was a fierce advocate for increasing access to care for some of the city's most vulnerable residents. Her collaborative approach led to significant partnerships linking Dimock to world-class institutions such as Harvard Medical School, Beth Israel Deaconess Medical Center and Partners HealthCare. An innovative physician administrator, Dr. Jordan was responsible for the successful transition to the Electronic Medical Record, established Dimock's first Institutional Review Board to pave the way for research using human subjects and in 2012 led the effort to secure a $4.9 million federal grant to expand the capacity of Dimock's health center facility.

Widely respected for her expertise and insight, Dr. Jordan has published articles in medical publications including The New England Journal of Medicine, was recently appointed to the Commonwealth of Massachusetts Health Planning Council Advisory Committee and served as one of seven governor-appointed physician members of the Commonwealth of Massachusetts Board of Registration. Dr. Jordan serves on the Advisory Board for the Kraft Center for Community Health at Partners HealthCare and in 2013 was named to the board of directors of The Boston Foundation.

An avid runner and biking enthusiast, Dr. Jordan is also engaged in community programs and active in the PTO. She and her husband Larry, an educator, live in West Roxbury with their two young daughters.

Irene S. Davis, PhD, PhD, PT, FAPTA, FACSM, FASB

Dr. Davis is a professor in the Department of Physical Medicine and Rehabilitation, Harvard Medical School and founding director of the Spaulding National Running Center. Dr. Davis received her bachelor's degree in Exercise Science from the University of Massachusetts, and in Physical Therapy from the University of Florida. She earned her master's degree in Biomechanics from the University of Virginia, and her PhD in Biomechanics from Pennsylvania State University. She is a Professor Emeritus in Physical Therapy at the University of Delaware where she served on the faculty for over 20 years.

Her research has focused on the relationship between lower extremity structure, mechanics and injury. Her interest in injury mechanics extends to the development of interventions to alter these mechanics through gait retraining. She is interested in the mechanics of barefoot running and its effect on injury rates, and is a barefoot runner herself. Along with gait analysis, her research encompasses dynamic imaging and modeling.

She has received funding from the Department of Defense, Army Research Office and National Institutes of Health to support her research related to stress fractures.

Dr. Davis has given nearly 300 lectures both nationally and internationally and authored over 100 publications on the topic of lower extremity mechanics during running.

She has been active professionally in the American Physical Therapy Association, the American Society of Biomechanics, and International Society of Biomechanics.
She is a Fellow of the American College of Sports Medicine, the American Society of Biomechanics, and a Catherine Worthingham Fellow of the American Physical Therapy Association. She is a past President of the American Society of Biomechanics. She has organized and coordinated international research retreats on topics of the foot and ankle, anterior cruciate ligament injuries and patellofemoral pain syndrome. She has been featured on ABC World News Tonight, Good Morning America, Discovery, The New York Times, The Wall Street Journal, Parade and Time Magazine.

Zolt Arany, MD, PhD

Dr. Zolt Arany is an associate professor of medicine in the Cardiovascular Institute at the Beth Israel Deaconess Medical Center and Harvard Medical School. He graduated from Harvard College, and received his MD-PhD from Harvard Medical School, during which time he worked with Dr. David Livington on novel molecular mechanisms driving the response of cancers to low oxygen.

After completion of Internal Medicine residency at Massachusetts General Hospital and Cardiology Fellowship at Brigham and Women's Hospital, Dr. Arany trained as post-doctoral fellow with Dr. Bruce Spiegelman at the Dana Farber Cancer Institute, investigating novel regulatory mechanisms of metabolism in heart and skeletal muscle. Dr. Arany's active laboratory currently focuses on how metabolism is regulated in heart and

muscle, with a focus on blood vessels. His lab has a particularly strong interest in how the heart and muscle respond to normal challenges of life, like exercise and pregnancy.

Dr. Arany has received a number of awards, including the American Heart Association Established Investigator Award, and he was recently elected to the American Society of Clinical Investigators. Dr. Arany also actively teaches courses to Harvard medical and graduate students.

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The inside scoop: Exercise and your body

What goes on inside your body when you pedal a bike or take a stroll? These activities set off complicated physical processes that affect nearly every organ system. When you exercise several times a week or more, your body adapts so you're able to do so more efficiently. Knowing about this process will help you understand why physical activity has so many benefits.

Energy to burn

Like all machinery, your muscles must have fuel. This fuel comes from the food you eat and your body's reserves of fat and glucose. The catch is that nutrients from food cannot be turned directly into usable energy for the trillions of cells in your body. Each cell has one primary source of energy: a molecule called adenosine triphosphate (ATP).

Your body's ability to create ATP is critical because it determines your capacity for physical exertion. And the reverse is also true: your physical conditioning influences how well you can generate ATP.

The food you eat contains energy stored in a variety of forms — proteins, fats, and carbohydrates. Your body needs to extract that energy and capture it in the form of ATP. To do this, your stomach and small intestine break the food into millions of tiny molecules, which enter the bloodstream and find their way to every cell in the body (see the figure). There, in small cell structures called mitochondria, the food molecules undergo a series of chemical reactions that ultimately lead to the creation of ATP.

Your body stores only a small amount of ATP, but makes it as quickly as it's needed. When demand increases — such as when you are exercising — your body must churn out more. To do this, it taps into glucose stored in the muscle and liver and fats from various places in the body. These substances make their way through the bloodstream to the muscles.

Stored glucose (also known as glycogen) and fat can be broken down for ATP production in two ways: aerobic (requiring oxygen) and anaerobic (requiring no oxygen). Aerobic processes produce more ATP, but grind to a halt without oxygen. When your body is working so hard that it is unable to deliver enough oxygen to support aerobic metabolism of food for fuel, it switches to anaerobic production of ATP, which creates a byproduct known as lactic acid. The lactic acid enters the bloodstream, creating an acid imbalance. To compensate, your breathing speeds up to take in more oxygen and your heart beats faster to move that oxygen to your muscles.

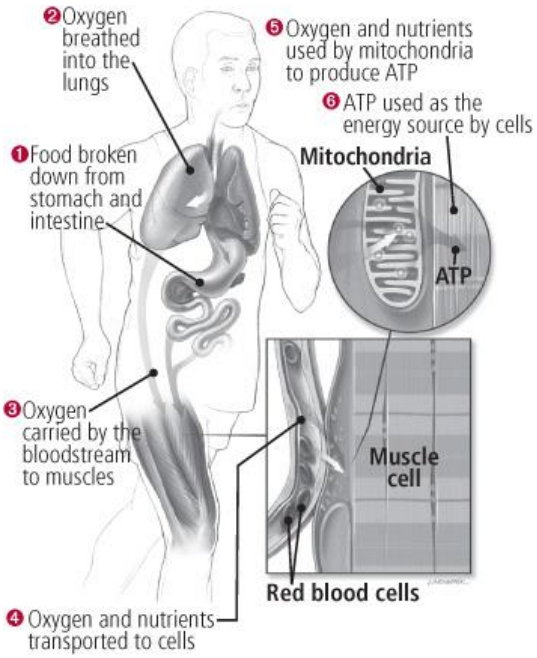
But you can't sustain anaerobic activity. Your lungs and heart reach their maximum work efforts, and your body can only neutralize the resulting acid imbalance for a short time. The lactic acid generated from the anaerobic process also leaves muscles feeling fatigued. Eventually, you need to slow down. By doing so, you are able to take in enough oxygen that once again you can rely primarily on aerobic

production of ATP. Lactic acid production stops, the muscles start to recover, and your body restores normal acid balance.

Your level of fitness determines how swiftly this happens. Regular exercise conditions the lungs, heart, and blood vessels, enabling them to deliver oxygen to muscle cells more quickly and efficiently. Walking up a hill with a fitter friend illustrates this nicely. While you're still huffing and puffing, your friend isn't struggling to catch her breath.

When you engage in physical activity, your body doesn't rely solely on one process or the other; both are used to generate ATP, but one more so than the other. Because of this distinction, exercise is classified into two broad categories — aerobic and anaerobic — depending on which process is predominantly used for ATP production. If the intensity of exercise is such that your lungs and heart are able to supply oxygen for energy production, then the activity is almost exclusively aerobic. But if intensity rises so that demand for oxygen outstrips supply, then the activity becomes anaerobic. Walking, jogging, cycling, or swimming at an even pace are aerobic activities. Activities in which your body tends to go anaerobic more quickly include wind sprints and weight lifting.

Food, oxygen, and energy



Once the food you eat is digested in your stomach, its components are absorbed into your bloodstream and delivered to cells throughout the body. Oxygen from your lungs also travels to your cells, where tiny structures called mitochondria use it to convert the food nutrients into a chemical called adenosine triphosphate (ATP), which provides energy for everything from walking to thinking.

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Heart and blood vessels

Your cardiovascular system transports oxygen to cells and removes carbon dioxide, carries away metabolic waste products, and shuttles hormones to the intended organs. In addition, it helps maintain body temperature and preserve your body's acid balance. Most people can engage in light activity, about the equivalent of walking 2 mph, without placing excess demand on their circulatory and respiratory systems. When you exercise more intensely, however, your muscles' need for oxygen increases. Your heart must pump harder and faster. The amount of blood your heart pumps and the oxygen your body consumes rise in direct proportion to the amount of work your muscles are performing. And once again, your level of physical conditioning dictates how well this system works.

Arteries in your working muscles dilate to accommodate their increased need for blood. At the same time, the heart's increased output causes your blood pressure to rise. Arterioles (tiny arteries) in your skin expand, allowing for more blood flow there. As you continue to exercise, especially in hot, humid weather, more blood is diverted to your skin to maintain a safe body temperature.

While your arteries dilate, veins serving distant parts of your body contract. When you are resting, the venous system stores roughly 65% of the body's blood supply. But when veins contract, they make more blood available to your heart and exercising muscles. Your body further optimizes the distribution of blood by limiting the amount sent to the kidneys, liver, digestive system, and other organs not immediately involved in the exercise process.

When you exercise regularly, your circulatory system adapts by boosting your cardiorespiratory endurance. Your body creates more plasma, the saltwater fluid that carries glucose and other nutrients to cells and ferries away waste. Because plasma is a component of blood (along with blood cells), a greater volume of blood is available to pump. That blood is slightly thinner than usual, which lowers the resistance it encounters while circulating. The main pumping chambers of your heart, called the ventricles, stretch to hold more blood and contract with greater force. Over the long term, the heart muscle increases in size, which strengthens the heart.

Likewise, the capillaries that serve the working muscles — including the heart — increase in number. These additional blood vessels serve two valuable functions. First, they feed the muscles more oxygen-rich blood. Second, the presence of more vessels means that the heart's powerful pumping chamber, the left ventricle, has a more plentiful energy supply and is able to pump the blood with greater ease. The more efficient pumping action allows you to do more work with less effort.

The greater need for oxygen-rich blood that occurs during aerobic exercise can also lead to an increase in the size and number of branches of the coronary arteries feeding the heart. This provides other channels for oxygenated blood to reach heart muscle. So if an artery serving the heart becomes blocked, heart muscle damage is less likely because alternative channels keep the blood supply flowing. The boost in oxygen and other benefits of exercise offer some protection against dangerous heart rhythm disturbances as well.

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Muscles

When you decide to move a part of your body, your brain transmits the message to your muscle fibers via your nerves. The fibers respond by contracting, which creates motion. To reverse the movement, your brain signals fibers in the opposing muscle group to tighten. For example, when you contract your biceps, the triceps on the back of your arm relaxes.

Exercises that involve continuous motion, such as rowing, walking, or swimming, result in the rhythmic tightening and releasing of muscle fibers. In addition to moving your body, this process produces a "milking" action that helps move blood through your veins and back to your heart. With aerobic exercise, an increase in fibers containing iron-rich myoglobin also occurs, permitting more oxygen to enter and be stored in the muscle.

Combined with the greater number of capillaries and increased blood flow to the muscles, these changes improve muscular endurance. Fit muscles adapt in other ways, too. Well-trained muscles not only are able to stockpile more glycogen, but they also can burn fat for energy more directly, which preserves glycogen stores.

Exercise by the numbers

While you exercise:

- Unless you are taking medications, your heart rate can reach 130 to 150 beats per minute (sometimes higher, particularly in young, fit individuals). That nearly doubles the resting norm of 70 to 80 beats per minute for most people.
- Your heart may pump up to 20 liters of blood per minute (40 liters for well-trained endurance athletes), which is quadruple the 5 liters per minute that's typical while resting.
- Your skin and muscles receive 80% of your total blood flow. This quadruples the usual 20% of blood flow these areas get during rest.
- Systolic blood pressure (the top number) increases by 20 millimeters of mercury (mm Hg) or more during the first few minutes of exercise before leveling off. The diastolic reading (bottom number) remains largely unchanged. After you cease strenuous activity, however, blood pressure drops to lower than pre-exercise levels for two to three hours. Over time, regular exercise can help you maintain lower blood pressure.
- Millions of capillaries open up to feed muscle fibers.
- Your lungs pass up to 200 pints of air in and out each minute. When not exercising, the average for most people is 12 pints a minute.

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Bones

Throughout your life, your body is constantly building and dismantling bone tissue. This maintains your skeleton by replacing old bone with new bone and frees calcium, the main building block of bone, for other tasks. Calcium is vital to many physical processes, including maintaining heart rate and blood pressure, and a small amount of it circulates in your blood. When the amount of calcium in your blood gets low, your body draws on the reservoir of calcium stored in the bones.

Early in your life, your body builds bone faster than it loses it. But with age, bone is lost more rapidly than it's formed. Eventually, this leaves bones more fragile and susceptible to breaks. Exercise plays a key role in slowing bone loss. Muscle is tethered to bone by cords of tissue called tendons. Tendons tug on bones during physical activity. This stress increases bone strength and density. Exercises that work against gravity (such as walking, jogging, tennis, basketball, and strength training) provide the greatest benefit.

Hormones

Exercise affects nearly all of the dozens of hormones your body produces. Two of these substances, epinephrine and norepinephrine, are key players in promoting physical changes while you are exercising. When your brain detects more muscle movement, it responds by releasing this pair of chemicals, which speed your heartbeat, contract arteries serving non-exercising parts of your body, and stimulate the release of sugars and fats from body stores for energy.

Endorphins, natural opiates that help block pain perception and may improve mood, rise after 30 minutes or more of exercise. These hormones are probably responsible for the sense of euphoria endurance athletes are said to experience, sometimes called a "runner's high." Norepinephrine also regulates mood.

Insulin, a hormone made in the pancreas, fluctuates in response to exercise. Insulin's main function is to help usher glucose from the bloodstream into cells. While exercise boosts the concentrations of most hormones, levels of insulin drop during and for a short while after vigorous activity. This seems counterintuitive, because exercise accelerates the muscles' demand for fuel in the form of glucose. However, insulin transports glucose more effectively during exercise, so less of it is needed. Also, exercise seems to enhance your body's ability to draw energy directly from fat stores.

Research has found that exercise can also affect levels of estrogen. After menopause, when a woman's ovaries stop producing estrogen, fat tissue becomes her body's major source of estrogen. Some evidence suggests regular vigorous activity — and possibly moderate activity as well — may reduce circulating estrogens on an ongoing basis, partly because women who exercise tend to be leaner. This would expose breast cells to less of this hormone, which fuels many cancers.

Immune system

Experts believe that moderate exercise reduces levels of stress hormones and other chemicals that suppress immune system functioning and increase inflammatory activity. Other changes occur, too. A

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2005 study measured immune components in 15 healthy women during exercise and at rest. Researchers noted modest, short-term upswings in natural killer cells and white blood cells after 30 minutes of walking compared with sitting.

Although the immune system returns to a pre-exercise state shortly after the exercise session is done, moderate activity on a daily or almost-daily basis seems to have a cumulative benefit for your immune system, improving its ability to fight off infection.

To learn more…
This information was prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It was excerpted from the Special Health Report *Exercise: A program you can live with*. You can learn more about this publication at hvrd.me/tZRRT.

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What can exercise do for you?

Many people spend more than half their waking hours sitting down. And activities that don't enhance health account for quite a lot of the remainder. This growing trend may cause more trouble than most people realize. Observational studies suggest habitual inactivity raises risks for obesity, diabetes, cardiovascular disease, deep-vein thrombosis, and metabolic syndrome.

In fact, one study that followed more than 50,000 middle-aged women for six years found that even among women who were avid exercisers, the more television they watched, the more likely they were to gain weight or develop diabetes — regardless of how much physical activity they did. For every two hours the women spent watching television each day, they had a 23% greater risk of becoming obese and a 14% greater risk of developing diabetes. Sitting at work for many hours also heightened their risks for obesity and diabetes. When planning your day, it may be beneficial not only to increase the time you spend exercising but also to try to reduce your "sitting time."

The case for exercise is strong. Decades of solid science confirm that adding as little as half an hour of moderately intense exercise to your day improves health and extends life.

Here's a quick snapshot of the benefits exercise provides — not just while you are engaging in the exercise, but also over the long term:

- Lessens the likelihood of getting heart disease, the No. 1 killer of both women and men in America. Exercising regularly helps prevent plaque buildup by striking a healthier balance of blood lipids (HDL, LDL, and triglycerides), helps arteries retain resilience despite the effects of aging, and bumps up the number of blood vessels feeding the heart. It also reduces inflammation and discourages the formation of blood clots that can block coronary arteries. Even if you already have heart disease, exercise lowers your chances of dying from it.

- Lowers blood pressure, a boon for many body systems. Long-term hypertension (high blood pressure) doubles or triples the odds of developing heart failure and helps pave the way to other kinds of heart disease, stroke, aortic aneurysms, and kidney disease or failure.

- Helps prevent diabetes by paring off excess weight, modestly lowering blood sugar levels, and boosting sensitivity to insulin so that less is needed to transport glucose into cells. If you have diabetes, exercise helps control blood sugar.

- Reduces risk for developing colon and breast cancers, and possibly cancers of the endometrium (uterine lining) and lung. By helping you attain a healthy weight, exercise lessens your risk for cancers in which obesity is a factor, too.

- Helps shore up bones. When combined with calcium, vitamin D, and bone-saving medications if necessary, weight-bearing exercise like walking, running, and strength training helps ward off age-related bone loss. And balance-enhancing activities, including tai chi and yoga, help prevent falls that may end in fractures.

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- Helps protect joints by easing swelling, pain, and fatigue and by keeping cartilage healthy. Strong muscles support joints and lighten the load upon them. Activities that boost flexibility, such as stretching, yoga, and tai chi, extend range of motion.

- May limit and even reverse knee problems by helping to control weight — quite a bang for the buck, since every pound of weight lost reduces the load on the knee by 4 pounds.

- Lifts spirits by releasing mood-lifting hormones and relieving stress. In some studies, exercising regularly has helped ease mild to moderate depression as effectively as medications; combining exercise with medications, therapy, and social engagement is even better.

- May boost your ability to fend off infection.

- Adds years to your life. In the long-running Framingham Heart Study, moderate activity tacked on 1.3 years of life for men and 1.5 years of life for women versus low activity. Raising the bar to high activity added 3.7 years for men and 3.5 years for women.

To learn more…
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The fundamentals: What you need to know to get started

How much exercise do I need?

You can track either your time or calories, or both, to make sure you're getting enough exercise. If you have been sedentary for a long time or have certain health problems, be sure to work up to these goals gradually.

Time. The 2008 Physical Activity Guidelines for Americans recommend at least two hours and 30 minutes (150 minutes) of moderate aerobic activity per week. If you enjoy vigorous aerobic activities, you can pare this down to at least one hour and 15 minutes (75 minutes) per week. An equivalent combination of the two also fills the bill. As a guide, one minute of vigorous-intensity activity equals about two minutes of moderate-intensity activity.

Twice a week, also set aside time to do strength exercises for all the major muscle groups (legs, hips, back, chest, abdomen, shoulders, and arms). Older adults at risk for falls benefit from including balance exercises, too. Even if you are not able to reach the minimum exercise guidelines right away, it is important to do as much exercise as you are able and try to increase it gradually.

The physical activity guidelines reflect the minimum amount of exercise recommended for adults. For even greater health benefits, adults who are able should strive for five hours per week (300 minutes) of moderate-intensity aerobic activity or two-and-a-half hours (150 minutes) of vigorous-intensity aerobic exercise. Again, you can also mix the two. Adults with health problems that limit their ability to exercise should strive to do as much as they can.

Calories. Health benefits kick in when you expend between 500 and 1,000 calories per week through physical activity, although many studies find additional and extended health benefits flow from expending closer to 2,000 calories a week. For example, one *New England Journal of Medicine* study analyzed research conducted on 17,000 Harvard alumni. The greatest gains in longevity and lowered risk for disease occurred among those expending approximately 2,000 calories per week through dynamic physical activity, such as walking, gardening, or sports. The most active group recorded an average two-year gain in life span.

How often should I exercise?

The 2008 Physical Activity Guidelines don't spell out how many days a week you should exercise; instead, they focus on overall time per week. Generally, though, experts recommend spreading activity throughout the week and being active at least three days a week.

Starved for time? It's tempting to wonder if you can compress activities into one or two days a week. While scientists haven't delved into this extensively, some research tantalizingly suggests that "weekend warriors" who regularly burn through more than 1,000 calories in one or two sessions a week do have a

lower risk of dying than entirely sedentary adults — that is, if they have no major risk factors. However, safety issues, common sense, and the bulk of research stressing benefits that flow from regular activity on most days of the week argue against adopting this pattern.

How long must my exercise sessions be?

Sessions as brief as 10 minutes of aerobic exercise deliver health benefits, so do what works best for you. For example, one person may prefer doing three 10-minute exercise sessions a day for five days in order to meet the guidelines, while another may prefer walking 30 minutes twice a week and cycling along a bike path for 90 minutes on a sunny weekend day.

How vigorously should I exercise?

Whether you are healthy or have medical issues, moderate activity is safe for most people and does plenty to improve your health. If you're in good shape, adding vigorous activities to your workouts cuts time spent exercising and is a boon to health. If you're not fit, work up to vigorous activities slowly. Higher-intensity activities raise your chances for muscle or joint injury and very slightly increase the odds of developing a serious heart problem. This applies particularly to people who are unaccustomed to physical activity, who suddenly start exercising vigorously (although the overall risk of dying from heart disease is lower than if you did no exercise).

How can you judge the pace of your workout? The easiest way to measure exertion characterizes the intensity of an activity through broad categories, such as light, moderate, or vigorous (see the table). Called perceived exertion, it's especially helpful for staying in a safe range of activity. As you improve your fitness, you'll find your perception of the intensity of a particular activity — walking up a nearby hill, for example — changes.

The table describes physical changes at each level of exertion. If you're just getting started with an exercise program, aim for a moderate pace. (If health problems or disabilities make moderate activity impossible, simply do as much as you can.) As you build up, try a mix of moderate and vigorous activities to help build endurance. As you work out more often, you'll notice gains as exercises become easier. Whenever an activity becomes easy, boost the length of your workout or your intensity again.

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How hard are you working?

Intensity	It feels	You are…
Light	Easy	• Breathing easily • Warming up, but not yet sweating • Able to talk — or even sing an aria, if you have the talent
Light to moderate	You're working, but not too hard	• Breathing easily • Sweating lightly • Still finding it easy to talk or sing
Moderate	You're working	• Breathing faster • Starting to sweat more • Able to talk, not able to sing
Moderate to vigorous	You're really working	• Huffing and puffing • Sweating • Able to talk in short sentences, but concentrating more on exercise than conversation
Vigorous	You're working very hard, almost out of gas	• Breathing hard • Sweating • Finding talking difficult

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Be SMART

Fitting exercise into your life will pay off in everyday activities, sports successes, stronger muscles, independent living, and all-around fitness. Sounds great, right? Even so, marshaling the time and will to exercise may not be easy. Experts say you're more likely to meet success if you set goals that are SMART—that is, specific, measurable, achievable, realistic, and time-based. So as you're setting a goal and penciling it in on the worksheet we've provided, make sure it passes the SMART test, described below.

SMART: Set a very **specific** goal—for example, *I will do strength training on Mondays and Wednesdays.* Or, *I will do a set of front and side planks on Tuesday, Thursday, and Sunday.*

S**M**ART: Find a way to **measure** progress—for instance, *I will log my efforts daily on my calendar, checking off days when I met my goal.*

SM**A**RT: Make sure it's **achievable**. Be sure you're physically capable of safely accomplishing your goal. If not, aim for a smaller goal initially.

SMA**R**T: Make sure it's **realistic**. Choose the change you're most confident you'll be able to make, not the change you most need to make. Focus on sure bets: on a scale of 1 to 10, where 1 equals no confidence and 10 equals 100% certainty, your goal should land in the 7–10 zone. If it doesn't, cut it down to a manageable size. For example, *I'll do cardio three times a week.*

SMAR**T**: Set **time** commitments. Pick a date and time to start—for example, *Starting this week, I'll get up half an hour earlier on Wednesday and Friday to go to a yoga class.* Also choose weekly check-in times to keep track of whether you're meeting goals or hitting snags: *I'll check my calendar every Friday evening and decide if I should make any changes in my routines to succeed.* Outside deadlines can be really helpful here, too: Signing up for a tennis tournament or knowing you'll need to wiggle into beach clothes in six weeks prods you to get your exercise program under way.

Motivate yourself

Usually, we do our best work when motivated. That extends to exercise, too. It's not uncommon to launch a new exercise program raring to go, only to wind up back on the couch with your feet propped up just a few weeks later. If your will wavers, the tips here may help.

Refresh your memory. Remind yourself how the exercises will help you by reading your goals again. Emphasize the positive aspects. Rather than sternly saying, "I should do my workout," try saying aloud "My back feels better when I do my exercises," or "My backhand and serve are much stronger when I exercise consistently."

Find the time. Skimming time from your busy schedule is an art. Here are some ideas that can help. Over the course of a week, skip two half-hour TV shows, or exercise while you watch; you can also fit exercises into commercial breaks or downtime in your workday. Get up half an hour earlier each day to

finish a full workout. Throughout the day, be on the lookout for pockets of time. Be efficient: a short, challenging workout tunes up muscles just as well, if not better, than racking up set after set of easier exercises. As you advance to more challenging exercises, leave the simpler ones behind to make the best use of your time.

Slip exercises into your day. While on the phone, do 10 side leg lifts or pliés, or try a few stretches. Before shifting from calls to other projects or back again, do a few front or side planks. Spend the first five minutes of your lunch break doing reverse lunges or squats with knee lifts.

Plan simple rewards. Give yourself a pat on the back for every small or big step toward success. Blast your favorite tune at the end of a workout. Download the "Attaboy" app for your smart phone or tablet to enjoy a stream of compliments whenever you need to hear it. A bigger reward for staying on track toward your goal for two to four weeks might be new workout gear or sports equipment you'll enjoy.

Get a workout buddy. Workouts with a friend or family member are more fun, plus you're less likely to cancel on the spur of the moment. Or, if you belong to a gym, ask if there is a buddy program. Some gyms offer interactive workout equipment like Expresso bikes or Concept2 rowers, which let you race against a real or virtual buddy or compete in team or individual challenges.

At home, you could try using your computer and working out with a friend via Skype. If finding a real-time or virtual workout buddy isn't possible, go low-tech: ask a friend to check in with you regularly—on workout days or maybe just once a week—to give you a pat on the back or a pep talk.

Reach for your smartphone. Or iPad, computer mouse, or game system remote. Smartphone fitness apps, health-driven websites, and a slew of fitness games on systems like Wii and Xbox make it easy to set baselines and log calories and activities. Options like these can help you learn new exercises, track progress, and get friendly nudges that encourage you to stick to your goals. Check smartphone fitness options at Apple's App Store, Google's Android Market, or Blackberry's App World.

On the Web, try the American Council on Exercise fitness library (www.acefitness.org/exerciselibrary) or other virtual trainer and interactive tools. You can also find fitness games at local gaming shops, large retailers, and online stores.

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Not getting anywhere?

Brainstorming solutions for foreseeable bumps in the road can start you off on the right foot and help keep workouts on track. Once you get going, jot down any hurdles you run into and then think your way around them. Here's some help with common hurdles.

- Need the okay to start exercising? Call your doctor today. It may help to fax or send a copy of the workouts you hope to do, then follow up with a phone call to discuss whether any modifications will be needed.

- Don't belong to a gym (or can't seem to get to one)? Try doing bodyweight workouts, which require no equipment. Or buy the equipment necessary for doing certain workouts at home. Start with the less expensive items, such as medicine balls or a stability ball, and work up.

- Just don't feel motivated? Ask a friend to check up on you, or consider working out with a personal trainer.

- Not yet buff enough to make it through a workout? Try one or more of these options:

    1. Focus on the easy variations of exercises you find too hard.

    2. Start with fewer reps (or holding a position like a plank for fewer seconds). When that becomes easy, do additional reps or hold longer.

    3. Do just half of the exercises in a workout twice a week. Each week, try to add another exercise until you're doing the full workout.

- Bored by your routine? If you've mastered the basic moves, try the harder variations. Or change over to another workout entirely.

- Still stuck? Sometimes breaking a bigger goal down—*I want to do work out twice a week*—is the best way to succeed. For example, the options above offer a way to break down a big workout into more manageable steps.

To learn more…
This information was prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It was excerpted from the Special Health Report *Core Exercises*. You can learn more about this publication at hvrd.me/u1iOB.

Healthy Mind, Healthy Body
Benefits of exercise
Longwood Seminars, March 13, 2014

Planning worksheet

My goals are to

- enhance my health
- tone my muscles
- extend my endurance
- lose ____ pounds (a pound a week is reasonable, so break down bigger goals into smaller, manageable chunks) in the next ____ weeks
- strengthen my upper body
- strengthen my lower body
- strengthen my core and back muscles
- step up my game in a sport _____
- be able to enjoy _____

(Here, consider what tasks and fun you are missing out on. Does your back hurt? Are you finding it hard to make it up stairs, smash an overhead in tennis, or dig deep while gardening?)

Right now, I exercise

- rarely or never
- once a week for ____ minutes
- twice a week for ____ minutes
- three to five times a week for ____ minutes

I'd like to

- exercise ____ times a week for ____ minutes
- add cardio exercise to my weekly routine
- add strength training to my weekly routine
- change up my weekly routine

Healthy Mind, Healthy Body
Benefits of exercise
Longwood Seminars, March 13, 2014

My new plan:

Fill in some goals for a week, writing in cardio sessions like 30 minutes of brisk walking (remember, this can be in two or three chunks) or the workouts you plan to try. If you're wondering what mix of exercise to choose, read "Special section: Exercise 101" and see Table 1.

I can do

- _____ on Monday at _____
- _____ on Tuesday at _____
- _____ on Wednesday at _____
- _____ on Thursday at _____
- _____ on Friday at _____
- _____ on Saturday at _____
- _____ on Sunday at _____

I will gain support for my new plan by

- hiring a personal trainer on these days (circle those that apply):
  Monday Tuesday Wednesday Thursday Friday Saturday Sunday
- lining up an exercise partner for walks or workouts on these days (circle those that apply):
  Monday Tuesday Wednesday Thursday Friday Saturday Sunday
- telling a friend about my plan and asking her to check in with me once a week on _____ to cheer me on and encourage me to stay the course
- rewarding myself by doing _____ at the end of the week
- measuring my gains on _____

To learn more…
This information was prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It was excerpted from the Special Health Report *Workout Workbook*. You can learn more about this publication at hvrd.me/u240f.

Exercising the Mind

Scientists identify protein produced during muscular exertion that boosts brain health

By RICHARD SALTUS
October 10, 2013

A protein increased by endurance exercise has been isolated and given to non-exercising mice, turning on genes that promote brain health and encourage the growth of new nerves involved in learning and memory, scientists from Harvard Medical School and Dana-Farber Cancer Institute have reported.

The findings, published in the journal *Cell Metabolism*, help explain the well-known capacity of endurance exercise to improve cognitive function, particularly in older people. If the protein can be made in a stable form and developed into a drug, it might lead to improved therapies for cognitive decline in older people and slow the toll of neurodegenerative diseases such Alzheimer's and Parkinson's, according to the investigators.

"What is exciting is that a natural substance can be given in the bloodstream that can mimic some of the effects of endurance exercise on the brain," said Bruce Spiegelman, the HMS Stanley J. Korsmeyer Professor of Cell Biology and Medicine at Dana-Farber. He is co-senior author of the publication with Michael Greenberg, the Nathan Marsh Pusey Professor of Neurobiology and head of the Department of Neurobiology at HMS.

The Spiegelman group previously reported that the protein, called FNDC5, is produced by muscular exertion and is released into the bloodstream as a variant called irisin. In the new research, endurance exercise—mice voluntarily running on a wheel for 30 days—increased the activity of a metabolic regulatory molecule, PGC-1α, in muscles, which spurred a rise in FNDC5 protein. The increase of FNDC5 in turn boosted the expression of a brain-health protein, BDNF (brain-derived neurotrophic protein) in the dentate gyrus of the hippocampus, a part of the brain involved in learning and memory.

It has been found that exercise stimulates BDNF in the hippocampus, one of only two areas of the adult brain that can generate new nerve cells. BDNF promotes the development of new nerves and synapses—connections between nerves that allow learning and memory to be stored—and helps preserve existing brain cells.

How exercise raises BDNF levels in the brain wasn't known; the new findings linking exercise, PGC-1α, FNDC5 and BDNF provide a molecular pathway for the effect, although Spiegelman

and his colleagues suggest there are probably others.

Having shown that FNDC5 is a molecular link between exercise and increased BDNF in the brain, the scientists asked whether artificially increasing FNDC5 in the absence of exercise would have the same effect. They used a harmless virus to deliver the protein to mice through the bloodstream, in hopes the FNDC5 could reach the brain and raise BDNF production. Seven days later, they examined the mouse brains and observed a significant increase in BDNF in the hippocampus.

“Perhaps the most exciting result overall is that peripheral delivery of FNDC5 with adenoviral vectors is sufficient to induce central expression of *Bdnf* and other genes with potential neuroprotective functions or those involved in learning and memory,” the authors said. Spiegelman cautioned that further research is needed to determine whether giving FNDC5 actually improves cognitive function in the animals. The scientists also aren’t sure whether the protein that got into the brain is FNDC5 itself, or irisin, or perhaps another variant of the protein.

Spiegelman said that development of irisin as a drug would require creating a more stable form of the protein.

The research was supported by the JPB Foundation and National Institutes of Health grants DK31405 and DK90861.

Adapted from a Dana-Farber news release.

Life-Saving Exercise

In many common diseases, physical activity is as effective as taking drugs at reducing the risk of death

By JAKE MILLER
Harvard Medical School
October 2, 2013

Physical activity is potentially as effective as many drug interventions for patients with existing cardiovascular diseases and other chronic conditions.

In the few conditions where the life-saving benefits of exercise have been studied, physical activity was often found to be as effective as drugs at reducing the risk of death, according to the first study to aggregate and assess the comparative benefits of drugs and exercise for reducing mortality in a wide range of illnesses.

The study was published online in *BMJ* on October 1.

“We were surprised to find that exercise seems to have such powerful life-saving effects for people with serious chronic conditions,” said Huseyin Naci, an HMS visiting fellow in population medicine at the Harvard Pilgrim Health Care Institute, and a graduate student at the London School of Economics. “It was also surprising to find that so little is known about the potential benefits of physical activity for health in so many other illnesses.”

The study, conducted in collaboration with John Ioannidis, C.F. Rehnborg Professor in Disease Prevention and Director, Stanford Prevention Research Center, Stanford School of Medicine, found only four conditions where the effects of exercise on reducing mortality had been studied: prevention of severe illness in patients with coronary heart disease, rehabilitation from stroke, treatment of heart failure and prevention of diabetes.

In addition to providing guidance for patients and clinicians about the importance of discussing the potential benefits of exercise, the researchers highlighted the importance of continuing to research the value of exercise for health.

The researchers argue that more trials comparing the effectiveness of exercise and drugs are urgently needed to help doctors and patients make the best treatment decisions. In the meantime, they say exercise “should be considered as a viable alternative to, or alongside, drug therapy.”

“We’re not saying people who have had a stroke should go off their medication and head to the gym,” Naci said, “but having a conversation with their physician about incorporating exercise into their treatment might be beneficial in many cases.”

In the United States, 80 percent of people 18 and older failed to meet the recommended levels of aerobic and muscle-strengthening physical activity in 2011, according to the CDC. What’s more, the average number of retail prescriptions per capita for calendar year 2011 was 12.1, according to the Kaiser Family Foundation.

For the current study, the researchers analyzed the results of 305 randomized controlled trials involving 339,274 individuals and found no statistically detectable differences between exercise and drug interventions for secondary prevention of heart disease and prevention of diabetes.

Among stroke patients, exercise was more effective than drug treatment, while in congestive heart failure diuretic drugs were more effective than all other types of treatment, including exercise.

The authors point out that the amount of trial evidence on the mortality benefits of exercise is considerably smaller than that on the benefits of drugs, and this may have had an impact on their results. Of the nearly 340,000 cases analyzed, only 15,000 patients had had exercise-based interventions.

The researchers argue in the paper that this “blind spot” in available scientific evidence “prevents prescribers and their patients from understanding the clinical circumstances where drugs might provide only modest improvement but exercise could yield more profound or sustainable gains in health.”

Despite this uncertainty, the authors claim that based on the available data physical activity is potentially as effective as many drug interventions and more trials to address the disparity between exercise and drug-based treatment evidence are needed.

“What we don’t know about the benefits of exercise may be hurting us,” Naci said.

For More Information

If clicking on a link below does not take you to the website, please copy and paste the URL into your browser

Spaulding National Running Center
http://www.runsnrc.org/RUNSNRC/Home.html

From the Heart: A Physician-Scientist Tells Us What Makes Him Tick (Q&A with Zolt Arany)
http://www.bidmc.org/Centers-and-Departments/Departments/Cardiovascular-Institute/CVI-Newsletter/Archives/Fall13/PhysicianScientist.aspx

Want Better, Cheaper, More Seamless Health Care? Ask Me How
WBUR (Guest post by Myechia Minter-Jordan)
http://commonhealth.wbur.org/2014/01/community-health-center-as-model

Aping the Early Human Workout
The Wall Street Journal (features Irene Davis)
http://online.wsj.com/news/articles/SB10001424052702303745304576357341289831146

Walking By the Numbers
Beth Israel Deaconess Medical Center
http://www.bidmc.org/Centers-and-Departments/Departments/Cardiovascular-Institute/CVI-Newsletter/WalkingSteps.aspx

The Benefits of Physical Activity
Harvard School of Public Health
http://www.hsph.harvard.edu/nutritionsource/staying-active-full-story/

Exercise as Preventive Medicine
The New York Times
http://well.blogs.nytimes.com/2013/10/09/exercise-as-preventive-medicine/?_r=1

How Exercise Could Lead to a Better Brain
The New York Times
http://www.nytimes.com/2012/04/22/magazine/how-exercise-could-lead-to-a-better-brain.html?pagewanted=all&_r=0

13 Mental Health Benefits of Exercise
The Huffington Post
http://www.huffingtonpost.com/2013/03/27/mental-health-benefits-exercise_n_2956099.html

9 Health Problems You Can Treat with Exercise
ABC News/Prevention Magazine
http://abcnews.go.com/Health/health-problems-treat-exercise/story?id=21659158

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