

GIZ ASKS

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Why Do Muscles Start Hurting Two Days After a Workout?



Daniel Kolitz
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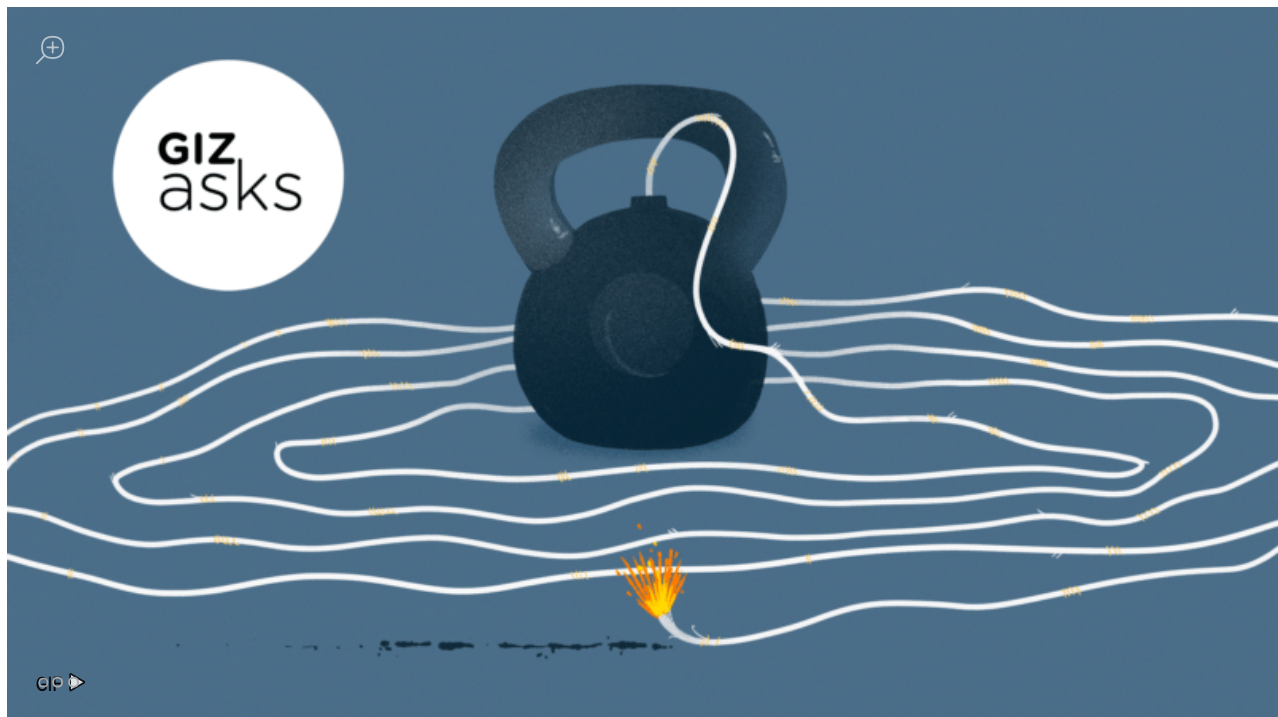
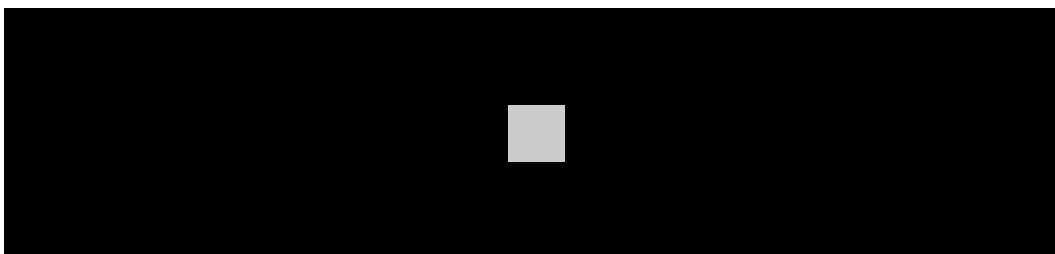
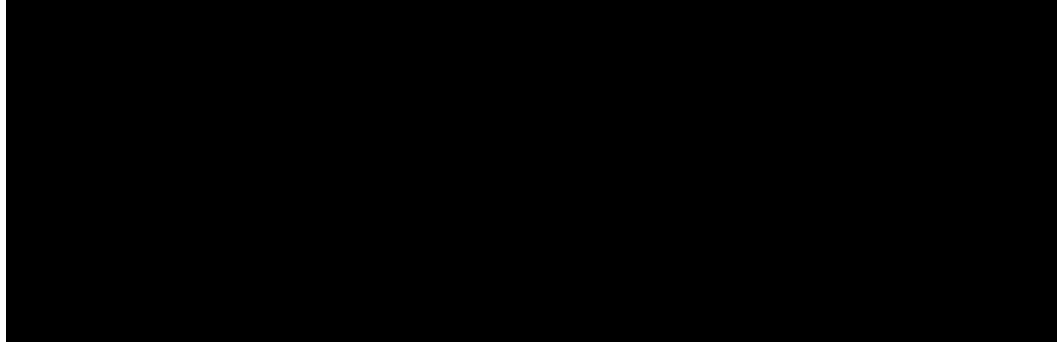


Illustration: Chelsea Beck/GMG

If you've decided, this year, to start working out, you might have noticed a strange phenomenon: You'll leave the gym feeling fine, and then two days later wake up sore. This weird time-lag appears unique to exercise, and is, when you think about it, kind of inexplicable—like stubbing your toe, feeling nothing, and then two days later suddenly yelping in pain.

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For this week's Giz Asks, we enlisted physiologists, molecular biologists and exercise scientists to help us figure out *why* workouts hurt two days after the fact—and it seems it's just as inexplicable to them. As it turns out, there's a whole burgeoning world of research devoted to figuring this thing out. And while scientists still haven't pinpointed exactly what causes it, there are some compelling theories out there.

Elaine Choung-Hee Lee

Assistant Professor, Molecular Biology and Applied Genetics, University of Connecticut

Post-workout soreness usually peaks 24-48 hours after what we would consider muscle-damaging exercise. This delayed pain is termed delayed onset muscle soreness (DOMS) and occurs because once muscle is damaged during exercise, the repair process takes time to proceed.

When muscle tissue is damaged, not only do resident tissue cells assist in repair and removal of damaged proteins, but also cells of the immune system localize to the damage site to facilitate tissue repair and recovery. A degree of local tissue inflammation occurs at the site as a result, while tissue cells, immune cells, repair and proteins, and other factors that stimulate repair all migrate to the site of damage.

Although this process is part of what contributes to pain associated with DOMS, it is an important aspect of response to exercise that does need to occur. Usually after a few days, DOMS subsides and this indicates that the healthy repair process has occurred. Prolonged and extremely painful soreness may be a sign of more severe injury or damage that requires longer recovery time between workouts. Aspects of the exercise itself like exercise intensity, duration, type, and also your fitness level can impact how severe DOMS is after a bout of exercise.

Matthew Ely

Graduate Employee, Department of Human Physiology, University of Oregon

Delayed onset muscle soreness (DOMS) is caused by strenuous exercise, above and beyond what the individual is used to performing. DOMS can occur from exercise using predominantly concentric contractions but is more prevalent following exercise with eccentric muscle contractions. The soreness is associated with temporary damage to muscle contractile proteins and/or the muscle sarcolemma. This pain usually peaks 24 to 48 hours after the exercise session.

The cause of the soreness, i.e. increased activation of nociceptive (pain) nerves, is currently unknown. Through our work we discovered that histamine production and release is increased during aerobic exercise. If we block histamine actions (antihistamines) we decrease the perceptions of pain/discomfort following the muscle damaging exercise. Blocking of histamine actions is associated with reductions in two known neurotrophic factors (Nerve Growth Factor and Glial Derived Neurotrophic Factor). These two factors cause changes in the nociceptive neurons causing them to discharge more often and with less stimulus. Both of which will increase perceptions of pain.

So, what causes DOMS? From our work at the University of Oregon we believe it is in part due to histamine release during muscle contractions. Therefore, blocking histamine actions during strenuous exercise may decrease perceptions of soreness/pain.

If there is muscle damage caused by strenuous exercise, the resultant pain/soreness is likely a protective mechanism preventing you from over extending the muscle again and allowing healing to occur. Blocking the soreness may delay healing or may result in increased damage if more exercise is performed.

Paul Ingraham

Publisher, PainScience.com

DOMS has always reminded me of knuckle-cracking—it seems simple but it ain't.

It's hard to get into in a way, because the only honest answer is: Nobody knows. It's just a mystery. But it's easy to get into in another way, because there are some really interesting theories, and interesting clues, so that makes it fun, but entirely speculative.

First of all, let's just dispense with conventional old-school wisdom, which is that it's basically a form of injury—that it's microtrauma. There may be an element of truth to that, but it's pretty clear that there are some features of this kind of pain that don't fit with that theory, and the delay is the most obvious. What other injury do you hurt more from two days down the road? Generally, if you hurt yourself, if there's straightforward tissue damage, you know it pretty much right away, and certainly it doesn't take 36 hours to reach peak intensity. That old idea that you've just damaged yourself is almost certainly wrong, or only a small part of the total picture.

At the opposite extreme, the most interesting new theory is based on a series of studies by some Japanese researchers. [The theory is] that it's basically just nerve growing pains. What these Japanese researchers showed is that the pain is related to neurotrophic factors—that is, substances that come out of muscle cells that stimulate nerve growth. This is an adaptive mechanism—your nerves are growing after exercising because they've received the message that, “hey, we need more going on here, we gotta make these muscles better.” And when nerves grow, it's uncomfortable in exactly the same sort of general sense that it's uncomfortable when you're ten years old and going through a growth spurt and your bones are aching. It's just a little tiny mini growth spurt for your nerves in the aftermath of getting a bunch of unfamiliar exercise. And that can certainly explain why it takes a while to get going, or why it increases as it goes.

One of the reasons research has failed is that we keep looking for one substance that's associated with it, one biomarker, and we now know that that's probably never going to happen. Some recent research revealed that there are several biological markers associated with DOMs, and that they probably only have an effect when they're all together, so it's a chemical stew. It's not that muscles produce one substance, or there's one molecule that is causing the pain. It's several all at once, and that prob has a lot to do with why we haven't been able to figure this out.

Another super-interesting detail that's emerged recently suggests there's something mysterious going on with the immune system, and the key to this research is that inflammation isn't causing the pain. It's the something else that's

actually the pain, and the inflammation is just a side effect. This research explains why we're really sore after an unfamiliar workout, but then we do the same thing again in a week and it's not nearly as bad. The theory is that it's similar to immunity to infection—that we're basically exposing our muscles to something, that exercise stirs something up, the immune system reacts to it, and then the next time that we exercise the immune system is more ready for it and then we don't hurt as much.

Why is DOMS so hard to study?

There's two answers to that. The first is boring, which is that most of musculoskeletal and pain medicine is surprisingly primitive. We're at a point in history where we've only really just begun to take problems like this seriously, scientifically. The 20th century was a pretty great century for medicine but it was 98 percent devoted to the big diseases. Sports injuries and musculoskeletal medicine and back pain, it's just really brand-new. We've only just barely started. And even once we started, which was about 20 or 25 years ago, it's still kind of half-assed. It just doesn't get the money, there's not that much of a budget for it.

The more interesting reason that we don't have a lock on DOMS is that it just turns out to be super-complicated. None of the obvious things seem to turn out to be the case, and it's just turned out to be this super difficult little biological puzzle. It's very familiar experience, we all know about it, we all know what it feels like—it just happens to be fiendishly hard to explain biologically.

Craig Nolan

Residential Faculty, Exercise Science, Mesa Community College

The short answer is: No one knows for sure why [we get DOMS]. But it's kind of similar to an injury. Let's say that I sprain my ankle. Well, over the next 24 to 48 to 72 hours there's a repair process going on; the ankle doesn't all of a sudden start to feel better. It takes time for that pain to decrease, and it's kind of the same with this muscle soreness. When you work out, you're damaging your muscles, and when you damage a tissue it swells up. When it swells, it pushes on the nerves, which causes pain. And that swelling process doesn't just stop immediately. It takes time for that to decrease.

A lot of DOMS really depends on intensity of the exercise. If it's a low-intensity workout, you're not going to produce a lot of muscle soreness. It's more common in people that just begin to exercise, because their body is not used to exercising, so it needs time to adapt. If you do [a workout] that you're not used to doing, that can lead to muscle soreness.

Working out is a stress to your body. It's a good stress, if you're doing it right, and your body adapts to stressors. If you do the same thing over and over, and you don't increase the weight or anything like that, your body gets used to and doesn't need to get sore.

[DOMS] is a good thing to a certain extent, but lots of people base their workout on the fact that they're sore all the time. Well, if you're sore all the time, then that's not a good thing, because your body needs to adapt to exercise. If you're sore all the time, you're probably overdoing it.

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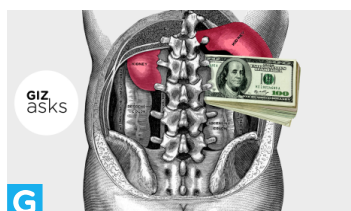
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