VOLUME 18, ISSUE 2

TUSTED Health

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WELCOME TO VOLUME 18, ISSUE 2 OF NIH MEDLINEPLUS MAGAZINE.

This issue includes articles about rare diseases, mental health, atrial fibrillation (AFib), and the impact of health disparities. We also feature interviews with celebrities who share their own health experiences and with NIH Directors about their institutes' work.

This issue's cover star, NBA Hall of Fame legend Kareem Abdul-Jabbar, tells us about his experience with AFib. He explains why he's advocating that everyone, but especially Black men, understand their risks for cardiovascular disease and talk with their doctor about protecting their health.

We also hear from NBC reporter Richard Engel, who shares his family's difficult journey with Rett syndrome. This rare disease took the life of his young son two years ago, and now Engel wants other parents facing this incurable disease to know they are not alone.

Continuing our "Meet the Director" series, we talk to George F. Koob, Ph.D., of the National Institute on Alcohol Abuse and Alcoholism. He details how he began researching alcohol and its effect on human health, and he talks to us about



what his institute is doing to improve treatment for substance use disorders. We also interview Eliseo J. Pérez-Stable, M.D., about leading the National Institute on Minority Health and Health Disparities. He describes how the COVID-19 pandemic changed our awareness of social determinants of health and how the attention to diversity in biomedical research is growing.

Plus, we continue our reporting on groundbreaking pain research at NIH and the evolution of prosthetic limb technology. We also hear from teenagers about coping with mental health struggles before and since the pandemic and how they found the help they needed.

Learn all about these and many other vital health topics in this issue of NIH MedlinePlus Magazine!

NIHMedlinePlus MAGAZINE

WHO WE ARE

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Kareem Abdul-Jabbar speaks out about heart health

Basketball legend promotes timely detection of atrial fibrillation

areem Abdul-Jabbar is a master of rebounds. On the basketball court, the six-time NBA Most Valuable Player's offense made history. But two years ago, he faced a new kind of opponent: atrial fibrillation, or AFib. This common form of heart arrhythmia (an abnormal heart rhythm) can lead to serious and potentially fatal health conditions.

Thanks to a timely diagnosis and a doctor's treatment plan, Abdul-Jabbar is bouncing back. He spoke to NIH MedlinePlus Magazine about his experience and why he advocates for regular health screenings.

Tell us about your diagnosis with atrial fibrillation.

When I first started to experience shortness of breath, fatigue, and lightheadedness, I dismissed the symptoms because they would come and go. I assumed they were signs of aging. But I was wrong. Over time, I experienced the symptoms more frequently, and they would interfere with activities that didn't cause me any problems before, like walking through an airport.

In 2021, I was leaving a Los Angeles Dodgers game and could not stand up without feeling so lightheaded that I thought I would collapse. I was eventually diagnosed with atrial fibrillation after my symptoms sent me to the hospital.

What was your reaction when you received the diagnosis?

I was surprised because before my diagnosis, I didn't know what AFib was. I've since learned that AFib is the most common type of irregular heart rhythm that prevents your heart's lower chambers from filling completely or pumping enough blood. Blood can pool in your heart, which increases your risk of forming blood clots and



The risk of AFib increases with age, as do the risks of other chronic heart conditions such as hypertension, coronary artery disease, and heart failure. AFib can also increase the risk of stroke. The number of strokes attributable to AFib increases from **1.5% in people** ages **50 to 59** to **more than 23% in people ages 80 and older**. Your risk of stroke and heart-related complications can be greatly reduced with proper treatment. If you have risk factors for AFib or stroke, it's important to have a health care professional follow your condition.

SOURCE: NATIONAL HEART, LUNG, AND BLOOD INSTITUTE

can lead to stroke and other heart-related complications. In fact, people with AFib are at about a five times greater risk of stroke [compared to the general population].

I also had to accept that I cannot do everything I did before. It's scary knowing that AFib increases your risk of stroke, but that's why it is so important to take your symptoms seriously and to speak with a health care professional.

What do you do to maintain your heart health and overall wellness?

Being diagnosed with AFib has changed my life in a big way. I have to closely follow the regimen provided by my doctors and make sure I stay on top of my medications and appointments. Because of my AFib diagnosis, I pay much closer attention to my health than I did before. "Seeking medical attention early may help reduce the risk of AFib contributing to a more serious condition such as stroke."

Why did you begin speaking up about your personal health challenges, and why do you advocate for addressing health disparities?

Black Americans are diagnosed with AFib at lower rates than White Americans. This is despite the fact that Black Americans are at a disproportionately higher risk for the health conditions that increase the risk for AFib. What's more, Black Americans with AFib are also at a significantly higher risk of stroke compared to White Americans with AFib. This shows why diagnosis and treatment are important.

I'm teaming up with Bristol Myers Squibb and Pfizer for the *No Time to Wait* campaign* to help raise awareness of AFib and its symptoms. We want everyone, but especially Black Americans, to learn more about the symptoms of AFib and the increased risk of AFib-related stroke.

What is your advice to others about AFib and getting regular check-ups and health screenings?

It is crucial to listen to your body and pay attention to your symptoms. If you experience an irregular heartbeat, heart racing, chest pain, shortness of breath, fatigue, or lightheadedness, it's important to discuss it with a health care professional. Only they can determine whether the symptoms indicate AFib or another medical condition. Seeking medical attention early may help reduce the risk of AFib contributing to a more serious condition such as stroke. You need to do what's best for you and your health, now.



Kareem Abdul-Jabbar played in the NBA for 20 years and, upon retiring in 1989, was the league's highest career scorer.

I know firsthand the impact AFib can have on your life, and I can't stress enough how important it is to learn about the symptoms and talk to your health care professional.

What are your goals for raising awareness about AFib?

More than 2 million people in the United States have AFib, and that is estimated to increase to 12 million by 2030. However, many people ignore their symptoms because they can come and go. Since many people in the United States may have AFib but remain undiagnosed, I want to encourage others to speak with a health care professional if they experience symptoms.

*NIH was not involved in the creation of the project, and reference to it does not constitute or imply endorsement by any federal agency.



FAST FACT: Atrial fibrillation, also known as AFib or AF, affects **more than 2 million adults** in the United States and is one of the most common types of arrhythmias (irregular heart rhythms). The risk of developing AFib increases with age, so as the average age in the United States increases, more people will be affected by this condition.

SOURCE: NATIONAL HEART, LUNG, AND BLOOD INSTITUTE



Atrial fibrillation: What you need to know

Atrial fibrillation is also known as AFib or AF. AFib is the most common type of arrhythmia disorder (when your heart beats too quickly, too slowly, or with an irregular pattern) in the world. AFib is specifically the rapid, irregular beating of the heart's left atrium or upper chamber.

What is AFib?

According to the National Heart, Lung, and Blood Institute, the heart's electrical system sends signals to the different chambers of the heart. These signals make the chambers beat regularly and ensure the heart pumps enough blood to the rest of the body. AFib causes the chambers to beat irregularly, which makes it harder for the heart to pump enough blood.

AFib can occur in brief or infrequent episodes. It can last for more than a week at a time, last for more than a year, or become permanent.

What causes an irregular heart beat?

Changes to the heart's tissue or electrical signaling affect its ability to contract in rhythm. Some factors that can cause these changes include:

- High blood pressure
- Coronary heart disease
- Inflammation
- Stretching, thinning, or thickening of the heart's walls
- Fibrosis
- Reduced blood flow to the heart
- Buildup of proteins, cells, or minerals in the heart tissue

What are the symptoms?

- Feeling tired, lightheaded, or dizzy
- Feeling like your heart is skipping a beat, fluttering, pounding, or beating too hard or fast
- Chest pain
- Low blood pressure
- Anxiety
- Shortness of breath

It's also important to know that many people with AFib do not experience any symptoms.

AFib can cause heart attacks and heart failure. It also increases the risk of ischemic <u>stroke</u>, which occurs when a blood clot blocks a blood vessel in the brain. This prevents blood flow to the brain, causing brain cells to start dying.

FAST FACT

In 2030, an estimated **12.1 million people** in the United States will have atrial fibrillation.

SOURCE: CENTERS FOR DISEASE CONTROL AND PREVENTION

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In AFib, the beating in the upper chambers of the heart (the left and right atria) becomes irregular. This makes it harder for blood to flow from the atria to the lower chambers of the heart (the left and right ventricles) and to the rest of the body.

What raises your risk for AFib?

Possible risk factors for AFib include:

- Aging. Risk increases with age, especially if you're over 65 years old.
- Family history. If someone in your family has had AFib, that could increase your risk.
- Genetics. Some genes that influence fetal organ development or heart cells can increase your risk.
- Surgical history. Your risk increases if you have had surgery for another condition of the heart, lung, or esophagus.
- Lifestyle habits. These include a wide range of factors, including drinking alcohol, using certain drugs, or regularly participating in endurance sports. Stress and panic disorders are also risk factors for AFib.
- Race. People of European ancestry are more likely to develop the condition, but Black or African American people with AFib are more likely to have serious complications such as stroke, heart failure, and heart disease.
- Certain health conditions. Sleep apnea, obesity, diabetes, and chronic kidney disease are some of the conditions that can increase your risk for AFib.

How is AFib diagnosed and treated?

A health care provider may recommend screening for AFib if you have symptoms or if you have certain risk factors for the condition. The provider may assess your family history of AFib and any prior history of heart disease. They may conduct a physical exam to check your heartbeat or to see whether you have swelling in your legs and feet.

Other common tests for AFib include:

- An electrocardiogram (ECG/EKG) to record your heart's electrical activity
- Blood tests for levels of, for example, potassium and thyroid hormones
- An echocardiogram (echo) to show the size and shape of the heart and how well it pumps blood
- Cardiac magnetic resonance imaging (MRI) to see the structure of your heart's left atrium and how it's working

To treat AFib, your doctor may call for lifestyle changes such as limiting or avoiding alcohol and stimulants, quitting smoking, or increasing physical activity. Your doctor may prescribe medicine to treat AFib or prevent complications such as stroke. In rare cases, cardioversion (an electrical shock to the heart) may be used to restore the normal heart rhythm. A procedure called catheter ablation (when a thin, flexible tube is inserted through veins or arteries into the heart) may also be used to treat AFib. A doctor may recommend surgery to restore your heart's regular rhythm if other methods have not worked.

NIH-funded research on AFib

The Rhythm Evaluation for Anticoagulation with Continuous Monitoring of Atrial Fibrillation Trial (REACT-AF)

This clinical trial will compare two treatments for preventing stroke in AFib. Researchers will test whether taking anticoagulant drugs (which prevent blood clotting) only when signaled by an AFib-sensing smartwatch is more effective than continuously taking them. If successful, this trial could lead to more individualized and cost-effective anticoagulant use in AFib patients. <u>Learn more about</u> <u>this research</u>.

Machine Learning in Atrial Fibrillation

Current therapies for AFib have limited success in part because researchers are not sure why a specific treatment works for a given patient. Machine learning (when a computer uses data to predict and perform processes without a person directly programming it) can improve our understanding of AFib. This project will use machine learning to recommend personalized therapies for patients with AFib. Learn more about this research.

JCH, that hurts.

The science of pain

Almost all of us have experienced pain of some kind. It's the most common reason why people seek medical care. But because people feel pain differently, there's no single treatment that will work for everyone.

ave you ever stepped on a sharp rock, accidentally rubbed your eyes after cutting a hot pepper, or struggled through a long workday with a throbbing headache? It may feel like the pain is happening in your foot, your eye, or your head, but your brain shapes how you experience pain and how you respond to it.

Scientific research funded, conducted, and supported by NIH has changed our understanding of pain—what it is, how it works, and how we experience it.

The many faces of pain

People experience pain in many different ways. Pain can range from the sharp feeling you get from a paper cut or a bee sting to the dull, persistent feeling of a sore muscle. In some cases, it's constant. In other cases, it comes and goes.

Pain can be acute or chronic:

- Acute pain is the pain you feel when you get hurt or injured. You may have experienced acute pain from an injury such as a cut or a broken limb or from disease or inflammation in the body. Acute pain can be intense and severe, but it typically resolves as your body heals from whatever caused it.
- Chronic pain is pain that lasts much longer—usually months and sometimes even years. Chronic pain sometimes has a clear cause such as an acute injury, a long illness, or damage to and dysfunction of your nervous system. Sometimes it even happens without any obvious reason.

Different kinds of pain have different causes:

- **Nociceptive pain** is pain caused by tissue damage. Most acute pain is nociceptive.
- Neuropathic pain is caused by nerve damage or dysfunction. You can experience neuropathic pain from injuries or illness that affect the spinal cord and brain (for example, a slipped disc in your spine) or the peripheral nervous system (the nerves throughout the rest of your body). This kind of pain often feels similar to burning, shooting, or stabbing.
- **Inflammatory pain** is pain that happens when your immune system activates in response to injury or infection. In addition to causing redness or swelling, it can also make you more sensitive to feelings of pain.

How we experience pain

When you are in pain, it's because your nervous system thinks that a part of your body is injured or in danger of getting injured (by accidentally touching a hot stove, for example). Pain is a normal sensory signal that something might be wrong and that you should do something about it. You don't become aware of pain until your brain processes it.



When a part of your body is injured, special pain receptors from that area release chemicals called neurotransmitters, which send messages to your brain.

The messages travel along nerves to the spinal cord and eventually to the brain, telling it, "Something might be wrong here, pay attention!"

Your brain receives and processes these messages, evaluates them, and decides what to do.



Your brain sends messages back to your body to react. Depending on the situation, this could mean rapidly triggering the muscles in your body to move you away from whatever is causing your pain. This reaction can feel instantaneous! If you are injured, your brain might also release natural painkillers called endorphins or tell your immune system to start healing the injury.

To see how this works, check out this MedlinePlus video on feeling pain.

By the numbers

The estimated yearly national cost of pain, including medical treatments, disability, and lost productivity, is \$560 billion to \$635 billion

More than **1** in **5** adults in the United States experience chronic pain

Rates of chronic pain, including pain that severely limits work or life activities, are highest among adults ages 65 and older

Chronic pain conditions such as low back pain and migraine are the leading cause of disability around the world

SOURCE: Centers for Disease Control and Prevention, National Center for Complementary and Integrative Health

How acute pain turns chronic

Most of the time, pain is a useful alarm system designed to keep us safe. But sometimes pain signals keep firing even after the body's tissues have healed.

When pain continues for a long time—such as during a long illness or after a serious injury—it can cause changes to your nervous system, which make you more sensitive to pain. This means that certain stimuli make you feel pain more quickly, and the pain can be more intense and last longer.

FAST FACT

Pain is the most common medical complaint

of older Americans. Causes of pain in older adults include joint pain, postsurgical pain, chronic disease,

and conditions associated with aging.

SOURCE: THE NATIONAL INSTITUTE OF NEUROLOGICAL DISORDERS AND STROKE

Treatment

Your experience of pain is influenced by a complex set of factors that are unique to you, including your genes and biology, past experiences, emotions, and environment. That means that everyone's pain feels differently. There isn't a way to measure it objectively, and there isn't one single treatment that will work for everyone.

Working with your health care provider to understand and treat pain safely and effectively is the best approach. Your pain management will depend on the kind of pain you're experiencing and what's causing it. It often involves a combination of treatments, which may include:

- Over-the-counter and prescription medications (such as pain relievers and drugs that reduce inflammation)
- Physical and occupational therapy to improve function and limit pain
- Counseling and therapy to teach skills for coping with pain
- Medical treatments (such as medications and injections) to interrupt pain signals or change how nerves process pain
- Neuromodulation therapies (devices that stimulate nerves or the spinal cord) to reduce pain
- <u>Complementary and integrative therapies</u> (such as acupuncture and mindfulness meditation)

FAST FACT

People born with an extremely rare genetic condition called **congenital insensitivity to pain** can't feel

pain. They are able to tell the difference between hot and cold or sharp and dull, but they can't feel the pain caused by a burn or a cut.

SOURCE: THE GENETIC AND RARE DISEASES INFORMATION CENTER

NIH research efforts

Many NIH institutes and centers are part of the <u>NIH Pain Consortium</u>, which works to advance pain research and promote collaboration among researchers.

The <u>NIH Pain Research Center</u> works to identify specific mechanisms and causes of pain in a range of conditions. The goal is to help researchers develop more effective, personalized ways to manage and treat pain, prevent chronic pain conditions, and reduce unwanted side effects such as opioid misuse and addiction.

The Helping to End Addiction Long-term[®] Initiative, or NIH HEAL Initiative[®], funds research in pain and addiction to address the national opioid public health crisis. HEAL programs are led by institutes and centers across NIH. They look for scientific solutions to prevent and treat opioid misuse and addiction. They also seek to better understand and treat pain by studying the biology of pain to identify new treatment targets, conducting clinical studies to test new treatments, and working with communities to make safe, effective treatments available to everyone who needs them.

The Back Pain Consortium (BACPAC) Research

<u>Program</u> is funded by the HEAL Initiative. The program conducts studies to better understand chronic low back pain, which is one of the most common chronic pain conditions. BACPAC is studying the multiple complex factors that contribute to low back pain.

The <u>Brain Research Through Advancing Innovative</u> <u>Neurotechnologies[®] Initiative</u>, or BRAIN Initiative[®], is an NIH-supported collaboration that aims to develop and apply new tools for understanding how the brain works. Scientists funded by the BRAIN Initiative are studying pain circuits in the brain to discover new ways to understand pain processing and to treat pain.

Shedding light on facial pain

Researchers at the National Institute of Dental and Craniofacial Research used an innovative technique to visualize pain signals in mice's facial nerves in real time. Their findings could help scientists develop safer ways to treat pain in the face, mouth, and jaw.

Joining forces to tackle facial pain

Pain is your body's way of telling you that something might be wrong and is the most frequent reason people seek medical care.

Facial and oral pain (in the face, mouth, and jaw) can be a symptom of injury, illness, or infection. It is one of the most common causes of pain complaints after neck, back, and knee pain.

Researchers at the National Institute of Dental and Craniofacial Research (NIDCR) wanted to explore new ways to treat facial pain without unwanted side effects. Two research teams joined forces to learn how nerves in the face send and receive information about pain. One team studies the biology of sensations such as pain, and the other has expertise in cell imaging.

Caught on camera

Ashok B. Kulkarni, Ph.D., has spent years studying a protein called *cyclin-dependent kinase 5* (Cdk5). Cdk5 is involved in pain signaling in other parts of the body, and Dr. Kulkarni and his team wanted to understand its role in facial pain.

To find out, they took mice and exposed parts of their faces to different kinds of stimuli: gentle brushing, poking, heat, and chili extract.



NIDCR scientists used fluorescence microscopy to visualize pain signaling in mice's facial nerves. Here, the flickers show how calcium surges in response to a painful stimulus.

p in



DID YOU KNOW?

Allodynia means "other pain." It is a symptom of nerve pain. It is linked to certain conditions that target the nerves such as migraine and fibromyalgia.

A burn, cut, or other painful stimuli like spicy food activates receptors on the skin's nerve endings. This triggers an influx of calcium, which acts as a message to the brain. The technique they used—called "fluorescence microscopy"—allowed the research team to watch this happen in real time as the individual cells in the mice's facial nerves responded to each of the stimuli.

"You see calcium go up and that [looks like] a flash of light," explained Kenneth M. Yamada, M.D., Ph.D., an NIH Distinguished Investigator. Dr. Yamada, who is Chief of the NIDCR Cell Biology Section, has expertise in developmental biology.

See animation at <u>National Institute of Dental</u> and Craniofacial Research



Dr. Ashok Kulkarni, left, and Dr. Kenneth Yamada, right.

Protein increases sensitivity to painful and nonpainful stimuli

Under the microscope, the team saw that mice who had high levels of Cdk5 showed larger calcium surges, indicating that their pain responses were intensified. Not only that, they were also more sensitive to *all* stimuli, not just the painful ones. The nerve cells responded the same way to light brushing as they did to heat and chili extract.

Dr. Yamada explained that this heightened pain sensitivity is similar to a condition called *allodynia*. Allodynia causes pain in response to something that isn't typically painful (such as light touch). The research team was able to reduce pain signaling in those oversensitive mice by blocking their Cdk₅.



The trigeminal nerve is part of the nervous system. It helps you bite, chew, and swallow. It also sends information about pain, touch, and temperature from your face to your brain. This nerve is involved in common orofacial pain disorders.

FAST FACT

Temporomandibular disorders (TMDs) include **more than 30 conditions**

that cause pain and dysfunction in the jaw joint and muscles that control jaw movement.

SOURCE: NATIONAL INSTITUTE OF DENTAL AND CRANIOFACIAL RESEARCH

Implications

Most pain medications work by interrupting pain signals between the brain and the body or by changing how our brains interpret those signals. These drugs can cause serious side effects because they act on multiple tissues and organs in the body. For example, narcotic drugs like opioids attach to certain receptors in brain cells. These block feelings of pain and increase feelings of pleasure, which can lead to dependence.

A drug that acts directly on the sensory neurons in the face rather than by suppressing pain signaling in the brain could offer a more direct, effective, and safer way to treat facial pain, Dr. Yamada said.

But Dr. Kulkarni explained that there's still a long way to go before scientists can start thinking about researching these techniques in larger animals and eventually in humans. They'll first need to identify additional compounds that act directly on Cdk5 and could be used therapeutically. One of the collaborators on the team is currently analyzing promising options. Eventually, these efforts could lead to new, safer treatments for facial pain. PAIN

Audio analgesia: How sound blunts pain—at least in mice



Music can make you feel better on a bad day, but can it literally take your pain away? Research suggests that music—and sound in general—may have the power to do just that. An international team of scientists, led in part by investigators from the National Institute of Dental and Craniofacial Research, studied mice to understand how this process works. Their findings could open the door to new, safer ways to treat pain in humans.

Music can take your pain away

Since the 1960s, music and other sounds have been found to ease pain from a range of different health conditions and procedures. Research shows that sound can reduce the pain of dental extractions, sickle cell disease, and childbirth, among others.

According to Yuanyuan "Kevin" Liu, Ph.D., an investigator for the National Institute of Dental and Craniofacial Research (NIDCR), music can grab our attention and help us relax. But his team's recent findings suggest the analgesic (pain-reducing) effect is from sound rather than music specifically. Dr. Liu studies sensory biology and pain. He is especially interested in the relationship between the mind and body and the role that perceptions play in this relationship.

To find out how sound dulls pain, Dr. Liu and a group of researchers in the United States and China turned to unlikely research subjects: mice with inflamed paws.

Playing Bach for mice

For three days in a row, Dr. Liu and his team exposed the mice to three different sounds:

- Harmonious classical music (composed by Bach)
- Inharmonious music (an unpleasant rearrangement of the same Bach piece)
- Background/white noise

The researchers used a technique to measure and compare the mice's pain sensitivity before and after hearing the sounds.

All three kinds of sound reduced the mice's pain. Surprisingly, the harmonious music was no more or less effective than the other sounds. The sounds also only reduced pain when played at very low intensities—just above a whisper. When the intensity increased, these effects disappeared.

Signal to the sound

Dr. Liu explained that it was not the sound's volume itself but rather the signal-to-noise ratio—the sound's intensity compared to the background noise. The sweet spot for pain relief was just above the level of the background noise.

Dr. Liu compared this to using background music played at a low volume, which he does when he needs to concentrate: "Just a little bit of sound, not too loud. Maybe that's the magic?"



NIDCR researchers found that low-intensity sound makes mice less sensitive to pain by disrupting pain signaling in the brain's pathway between the auditory cortex and thalamus.



Just a little bit of sound, not too loud. Maybe that's the magic?

Dr. Yuanyuan "Kevin" Liu studies sensory biology and pain at NIDCR.

Pain reduced for days

Stress, attention, and emotions are all involved in pain perception. When you hear music, for example, your attention temporarily shifts toward the sound and away from your pain. The mice heard the sounds for just 20 minutes a day for three days. But the pain-reducing effect lasted for several days after, which Dr. Liu said can't be explained by a shift in attention alone.

Stress reduction is another possible explanation, but the researchers did not see changes in the mice's stress hormones and behaviors after hearing the sounds. This suggested that something else was happening.

Pathways in the brain

Brain imaging studies in humans show that music can affect areas in the brain related to pain processing but not which specific neural networks are involved.

To find out, the researchers used imaging to trace neural activity in the mice's brains when they heard the sounds. They discovered a direct pathway between the part of the brain that receives and processes information about sound (called the auditory cortex) and the thalamus, which also receives information about sensations such as pain.

Dr. Liu described the thalamus as the brain's sensory information hub. All kinds of sensory information from inside and outside the body—including sound—come together in the thalamus, which affects how we experience or perceive that information. The low-intensity sound appeared to disrupt pain signaling in this pathway, making the mice less sensitive to pain.

Because the brain has a hard time processing input from different sensory systems at the same time, Dr. Liu said that lowering activity in the neurons in this pathway may be a way to manage some of these competing messages.

HOW IT WORKS



Sound comes in through your ear to your auditory cortex, which has a direct line of communication with the thalamus.



Similarly, pain receptors in the body send messages about sensations like pressure and temperature through the spinal cord to the thalamus.



The thalamus takes in information from different senses and sends messages about them to other parts of the brain.

What it all means

Understanding how processes in the brain regulate pain could help researchers develop new pain therapies in the future. Will your doctor start prescribing bluegrass, jazz, or classic rock tunes to ease your pain? Probably not any time soon. While these findings show how mice's brains regulate pain in response to sound, our brains may process and regulate pain in different ways. For example, Dr. Liu explained that humans have emotional connections to sounds such as music, and those connections are different for each person. Mice may also respond emotionally to different kinds of sound, but they do not have the language to tell us.

Dr. Liu said he wonders what roles other sensory processes might play in how we experience pain. If sound can affect our perception of pain, can light do the same thing? Researchers are exploring these questions and more, leading us closer to exciting new pain relief strategies.



Neurons located in different layers in a mouse brain's auditory cortex show as green (layer V) and magenta (layer VI) under a fluorescence microscope. Researchers from NIDCR discovered that sound reduces pain in mice by lowering activity in these neurons, which connect to the thalamus in the brain.



music therapy for pain and other health conditions

Music and pain

Research suggests that listening to music can help reduce acute and chronic pain. Music-based interventions may also help people with certain kinds of pain. This includes pain from fibromyalgia, multiple sclerosis, osteoarthritis, sickle cell disease, pregnancy and childbirth, and other health conditions, experiences, and treatments.

Other areas of health

Music-based interventions could also benefit other mental and physical health conditions.



Mental health and emotional well-being. Though more research is needed, music-based therapies may improve symptoms of depression and anxiety related to a range of health conditions. Music may also improve emotional well-being and quality of life in people with certain kinds of dementia or cognitive impairments such as difficulty with thinking, learning, memory, and decision-making.



Movement and speech. Certain music-based interventions show promise for some symptoms related to Parkinson's disease and multiple sclerosis, including motor function and balance.



Stroke. Some kinds of music-based therapies may be helpful during rehabilitation after stroke. For example, a technique called "rhythmic auditory stimulation" can help people improve their gait and balance after stroke by synchronizing their physical movement with rhythmic music or sounds.

The ways that music affects other areas of health are less clear. The evidence is mixed, limited, or uncertain for autism spectrum disorder, cognitive functioning among people with Alzheimer's disease and other dementias, chronic obstructive pulmonary disorder, and sleep disorders.

SOURCE: National Center for Complementary and Integrative Health



Uncovering a cure:

NIH-supported research lays the groundwork for understanding and treating pain

There's still a lot to learn because each of us feels pain differently

Pain affects millions of Americans. It's hard to measure, and there isn't a one-size-fits-all treatment approach. NIH conducts and supports basic, translational, and clinical research on pain, as well as strategies for treating it. Here are just a few recent examples.

From the lab to the bedside



Basic research

Conducted in labs by scientists who study the most fundamental building blocks of life, including genes, proteins, and cells. This kind of research helps us better understand living systems and processes.



Translational research Takes information learned from basic

research and studies how it can help improve health and treat diseases.



Clinical research

Studies different treatments and interventions to find out whether they are safe and effective in humans.



Basic pain research

Taking a closer look at facial pain

Researchers at the National Institute of Dental and Craniofacial Research (NIDCR) hoped to explore new ways to treat facial pain without unwanted side effects. To discover how nerves

in the face send and receive information about pain, researchers used an innovative technique to visualize pain signals in mice's facial nerves in real time. Their findings could lead to safer ways to treat pain in the face, mouth, and jaw. <u>Read about</u> <u>this research</u>.

Learning how sound reduces pain in mice

An international team of researchers, including some from NIDCR, studied mice to understand how sound can blunt pain. They discovered a direct pathway between two areas of the mice's brains: the auditory cortex, which receives and processes information about sound, and the thalamus, which receives and sends information about sensations such as pain. Understanding how processes in the brain regulate pain could help researchers develop new pain therapies in the future. <u>Find out more</u>.

Finding how our brains process pain differently

An international group of researchers, including some from the National Center for Complementary and Integrative Health, analyzed data from functional magnetic resonance imaging (fMRI) scans. They found that people's brains process pain in different ways, with some areas of the brain showing more variation than others. These results could lead to more personalized pain management approaches. <u>Read more about these findings</u>.



Translational pain research

Building a living pain circuit Developing new medications is challenging, costly, and time consuming. Researchers

must screen large numbers of possible medications if they want to identify even one promising molecule. To address this, scientists

funded by the <u>Helping to End Addiction Long-term</u>[®] <u>Initiative</u>, or the NIH HEAL Initiative[®], developed a system to quickly screen medication candidates. This "living pain circuit" is a 3D model of nerve cells that connect to each other the same way they do in the body. This tool can rapidly identify compounds that don't work in humans. This research is a step toward identifying new and effective pain relief treatments. <u>Read more about this work</u>.



Clinical pain research

Personalizing pain management after cesarean delivery

 Cesarean birth is the most common major surgery done in the United States.
 The Opioid Prescription After Cesarean Trial

(PACT), which is supported by the NIH HEAL Initiative, aims to reduce opioid use in people who had a cesarean delivery. PACT is a randomized clinical study that tests individualized pain management approaches for new mothers who deliver by cesarean. Half of the study participants will receive the current standard treatment (which is a prescription for a fixed number of opioid tablets) when they are discharged from the hospital. The other half will get a new patient-centered approach that allows participants to choose how many opioid tablets they are given and includes pain management and opioid use counseling. Find out more about PACT.

Ways to get involved

There are lots of ways you can contribute to pain research. Visit <u>ClinicalTrials.gov</u> to find out about acute and chronic pain research happening around the world and learn how to participate in clinical studies.

Current trials recruiting participants include research about:

- Low back pain. The BEST (Biomarkers for Evaluating Spine Treatments) Trial is part of the BACPAC Research Program. This study, sponsored by the National Institute of Arthritis and Musculoskeletal and Skin Diseases, tests four different evidence-based treatments for low back pain. The goal is to learn which treatments are most effective for people based on their unique traits, such as heart rate and blood pressure. Learn more and sign up to participate on the <u>BEST website</u>.
- Pain perception. NIH researchers are trying to better understand the different factors that affect pain and how people experience it. They also hope to learn more about how people's relationships with each other affect these experiences. This study is looking for healthy volunteers between the ages of 18 and 60 in the Washington, DC, metro area to participate. Find out how to participate.

Using virtual reality to treat real pain

Researchers from the NIH HEAL Initiative's Back Pain Consortium (BACPAC) are studying ways to use "therapeutic virtual reality" to ease chronic pain. Virtual reality allows people to experience immersive 3D environments—swimming with dolphins, for example which takes the brain's attention away from the experience of pain. This three-part research study is testing how effective virtual reality is for improving pain, reducing opioid use, and improving quality of life among people with chronic low back pain. Learn more about this research.

Weathering a rare childhood disorder

Richard Engel and his wife Mary lost their son Henry, right, in 2022 to Rett syndrome. Their younger son Theo was born in 2019.

Reporter Richard Engel shares his family's experience

s a chief foreign correspondent for NBC News over the past 15 years, Richard Engel has covered wars and conflicts around the world. The Peabody and Emmy Awards winner has faced dangerous and tense conditions to bring viewers reporting from Ukraine, Syria, Iran, and Afghanistan. Multiple journalism organizations have honored Engel for his courageous reporting in war zones. But in August 2022, he faced a different life challenge that proved even more difficult: He and his wife lost their 6-year-old son Henry, who was born with a rare genetic disorder called Rett syndrome.

They have since become advocates for others facing similar challenges. Engel talked with NIH MedlinePlus Magazine about his family's journey and the importance of rare disease research that organizations like NIH support. "We wanted to reach other parents facing similar challenges and let them know that they aren't alone."

Getting a diagnosis for a rare disease or disorder can sometimes be very difficult. What was your experience?

We knew almost as soon as Henry was born in 2015 that something was wrong, but what? He looked healthy and beautiful. His skin glowed. His eyes were open and bright. His organs and bodily functions ticked along. He cried, he wriggled, and he slept. He was an angel. But he seemed a little too angelic, a bit too quiet. He didn't have the strength to suckle. He could roll over but struggled more than other babies.

After repeated checkups and routine tests, our pediatrician was baffled and suggested we make sure Henry did plenty of tummy time to strengthen his core and neck. We knew that and had been doing it. The problem was far more profound.

It was only after speaking to several doctors at different hospitals around the world that Henry eventually had a DNA test, which gave us a blueprint of his genetic code. The process took months, and even still, the geneticists were left scratching their heads. They found a disorder that they thought only occurred in girls—a genetic variant that causes Rett syndrome, a devastating disease that leads to severe cognitive and physical impairments. We learned that boys can also have a variant of the same gene and have their own version of Rett syndrome, and it can be even more severe.

How did Henry's condition progress?

Our angel kept missing milestones. He could crawl a bit and feed himself, and he loved to giggle and play. He recognized us and could say a few words. He said "Dada" and "I love you." I will never hear sweeter words for the rest of my life. Henry's condition worsened over time; his development regressed and sharply declined in 2022. He passed away last August.



Richard Engel has been a foreign correspondent for NBC News for 15 years.

Why did you decide to speak out and tell your family's experience?

My wife Mary and I decided early on we wanted to share our experience so more doctors and families knew that boys could have a version of Rett syndrome. We wanted to reach other parents facing similar challenges and let them know that they aren't alone. And we wanted them to know they now had two more advocates among their ranks trying to do whatever we could to help.

What is it like it to be a parent or loved one facing a rare disorder like Henry's?

It is a long ride. It beats you up emotionally. Every holiday reminds you how different and more difficult your child's life is from many others. Every conversation with friends and other parents reminds you how different your lives are, too. But you have a purpose. You've seen behind the curtain. You don't have time for the small stuff. You have the double-edged gift of perspective. Our children are loved no matter how difficult their condition is—they matter most.

How can we fight the stigma associated with childhood rare disorders?

The only way to tackle the stigma is through visibility and awareness. These kids are out there. Their parents are out there. They need to go to the park as much as—and probably more than—any child. They want to laugh and play with other children, so play with them and be kind.

You've said that your son Henry gave you a gift. Could you speak to that?

For more than 25 years, I've worked as a foreign correspondent, bouncing between war zones. All wars are floods of disaster, with the occasional drop of selfless bravery and heroism. I surfed the tide of human misery, and it hardened me. It's called "compassion fatigue." Henry broke through all of that. He cracked the armor,





FAST FACT

Rett syndrome is named after **Andreas Rett**, an Austrian physician who published the first description of the condition in 1966.

SOURCE: INTERNATIONAL RETT SYNDROME FOUNDATION

and it slid off. I connected with him in a way I'd never felt before. His vulnerability and the pure love in his eyes left me vulnerable, too, and restored my compassion, especially for those who have to work harder in life, which is already pretty tough for everyone.

What's the importance of research like the studies supported by NIH?

Research is the way out of this. Henry wasn't sick; he had a genetic typo that limited him and ultimately took everything from him. But it's not an easy fix. You cannot just correct the glitch in his genetic code like you can in a software code and "Presto, problem solved!" We'll get there, or at least partly there, but only through research.

"Henry wasn't sick; he had a genetic typo that limited him and ultimately took everything from him."

Rett syndrome: An overview of this rare genetic disorder

What is Rett syndrome?

Rett syndrome is a rare genetic disorder in which a child's early growth and development regresses after initially meeting their <u>developmental milestones</u>. It is a neurodevelopmental disorder, which means it affects how the brain and nervous system develop. As a result, the child can have severe communication or coordination problems. Children with Rett syndrome may behave or move similarly to children with <u>autism spectrum disorder</u>, which is another neurodevelopmental disorder.

Symptoms

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Symptoms of Rett syndrome usually do not appear right away. Children with the disorder may meet age-appropriate milestones for the first 6 to 18 months before they start showing symptoms. Some common symptoms are:

1	Loss of speech	Ŕ	Balance problems
•	Loss of hand movements such	The second	Breathing problems
`	as grasping Compulsive		Social or problems

movements such as hand wringing



Who is more likely to have Rett syndrome?

Although Rett syndrome is a genetic disorder, most cases occur randomly—the chance that someone will inherit Rett syndrome is less than 1%. Children from all racial and ethnic groups may develop Rett syndrome, with most cases diagnosed in girls. It is caused by a mutation in the MECP2 *(methyl CpG binding protein 2)* gene, which is located on the X chromosome and contributes to brain development. Some girls with Rett syndrome also have female family members with the MECP2 gene mutation.

Not everyone with a MECP2 gene mutation will develop Rett syndrome.

Rett syndrome can begin as early as 6 months of age, with symptoms being so subtle that parents may not even notice the change in their child's development.



How can doctors find out whether a child has Rett syndrome?

There are prenatal screenings available to find a MECP2 gene mutation, but the same gene mutation in Rett syndrome can be found in other conditions. It is important to notify a doctor if a child shows behavioral changes or physical problems, especially if these changes happened after previously age-appropriate development. That can help a pediatric neurologist, clinical geneticist, or developmental pediatrician screen for and diagnose the disorder.

Is there a cure?

Not at this time. <u>Treatments are being developed</u> to help patients with Rett syndrome manage their symptoms. These may include medications, occupational therapy, special equipment to help children with physical movement, nutritional programs, and educational and social support. At NIH, the National Institute of Neurological Disorders and Stroke, the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, the National Institute of Mental Health, and the <u>Division of Rare Diseases</u> <u>Research Innovation</u> at the National Center for Advancing Translational Sciences all support research on Rett syndrome.

The Rett Syndrome Research Trust supports clinical research into treatments and cures for the disorder. The Trust also maintains a digital <u>Rett Syndrome Global</u> <u>Registry</u> for parents and caregivers to share data with doctors. The goal is to help track treatment results and research discoveries around Rett syndrome.

Meet the Director: NIH



National Institute on Alcohol Abuse and Alcoholism



George F. Koob, Ph.D.

Even after decades of research in the field, George F. Koob, Ph.D., is still learning new things about alcohol, its overall effects on human health, and alcohol use disorder. He has been Director of the National Institute on Alcohol Abuse and Alcoholism (NIAAA) since 2014, and he wants everyone to know what the institute has to offer. Dr. Koob talked to NIH MedlinePlus Magazine about his career, the neuroscience of alcohol use disorder, different NIAAA resources used to understand and treat this condition, and what he wishes more people knew about alcohol's effect on the body.

Tell us about your background and what brought you to the field of alcohol and drug addiction research.

A long time ago, in a galaxy far, far away, I wanted to be an ethologist (someone who studies animal behavior). I went to the Johns Hopkins University School of Public Health to study ethology, but my advisor was working on brain stimulation reward.

If you've ever seen a rat press a lever 100 times per minute to stimulate its medial forebrain bundle (the part of the brain that generates pleasure sensations)...I was hooked. I like to say that I spent the first half of my career studying why we feel good and the second half of my career trying to understand why we feel bad. I became interested in alcohol and other drugs of addiction and how it affects the brain.

How did you become Director of NIAAA?

Fast forward a few years to 1977, when I worked as a staff scientist at the Salk Institute for Biological Studies and joined the NIAAA-funded alcohol research center led by

Dr. Floyd Bloom. We then moved to Scripps Research in 1984 where we expanded to a major program on the neurobiology of alcohol use disorder that is still ongoing there. I became Director of the Alcohol Research Center at Scripps and Director of a branch of the NIAAA-supported Integrative Neuroscience Initiative on Alcoholism. This initiative seeks to understand the molecular basis of alcohol use disorder. Then, when the search for the Director of NIAAA was announced in 2013, I applied.

I had reached a stage in my career where I felt like we could do more to translate the basic research into [information that] people need. That was probably one of the guiding forces that moved me to want to work at NIH. And then when I interviewed with the fantastic institute Directors that were already at NIH-that was another plus. I met <u>Dr. Anthony Fauci</u>, and <u>Dr. Nora Volkow</u> and I already knew each other. There were just so many wonderful, unbelievably smart people, and I thought, "Wow, this has got to be really exciting!"

G G I had reached a stage in my career where I felt like we could do more to translate the basic research into [information that] people need."

How is NIAAA communicating more alcohol addiction research to the public?

In the last few years, we've really put a focus on making evidence-based information about alcohol available to the public. There's a big gap between what we know scientifically about alcohol and the public's understanding about alcohol, and even health care professionals' understanding about alcohol. It took me a little while as Director to get my head around what we knew, and I realized the extent of what we know and how little of that had been translated [to the public]. That includes screening and intervention, referring someone to a primary care doctor's office or any other health professional's office for treatment, and even understanding what a standard drink is. Those are the things that we have been missing and are the things that we've basically addressed since I became Director.

Translating evidence-based information about alcohol remains a challenge. We have learned an enormous amount about where alcohol works in the brain and what circuits are activated in different stages of the addiction cycle. I think, slowly but surely, we're using that information to develop better treatments for alcohol use disorder.

NIAAA is writing a new 2023–2027 Strategic Plan. How will this continue the work of the previous plan?

In the last five years, we created websites such as the <u>NIAAA</u> <u>Alcohol Treatment Navigator</u>, which provides people with not only information about what an alcohol use disorder is, but also the spectrum of treatment for alcohol use disorder. You can also type in your ZIP code and find the closest treatment facility.

Prior to my arrival at NIAAA, they developed the <u>CollegeAim Alcohol Intervention Matrix</u> to help universities address alcohol use issues among students. I suggested that we do similar things in other areas, including for other age groups, so that will continue in the new strategic plan.

Last year, we launched the <u>Healthcare Professional's Core</u> <u>Resource on Alcohol</u>. It explains everything you wanted to know about alcohol. It's aimed at primary care doctors, but



Dr. Koob, back row, fourth from left, stands with his lab group in the Neurobiology of Addiction Section of the Intramural Research Program at the National Institute on Drug Abuse, in 2022.

it can be used by everyone, from a pharmacist to a nurse practitioner, a clinical psychologist to a board-certified addiction medicine specialist.

We're going to be promoting that in the new strategic plan. We want everyone to know about this core resource on alcohol, and not just in health care—we've also sent it to every medical school in the country. We hope that we can influence medical school training and residency training. Those are some things that can directly help the public, and they're some of the things I'm most proud of.

How is NIAAA addressing health disparities in its research? How is NIAAA promoting diversity, equity, and inclusion in the biomedical workforce?

We've always had an emphasis on diversity, equity, and inclusion, but that's become an overriding theme at the institute—as it is for all of NIH. And we're working hard to expand our work in this area. We really believe that it will increase creativity, increase our relevance, and help people get better treatment.

Our mission is to provide evidence-based information about the diagnosis, prevention, treatment, and evaluation of alcohol use disorder and about the overall health consequences of alcohol. To only study one cultural group or type of individual or one sex or one gender is just not acceptable. There are so many individual differences in how we respond to alcohol and our vulnerability to the [harmful] effects of alcohol. That's one area that has shifted in priority for us.

Another is training young people and moving young people along in our field. That's another big area that we put a lot of emphasis on, and we will continue to do so.

To read more of Dr. Koob's insights on alcohol research, and how he unwinds from work, check out his full interview online at <u>NIH MedlinePlus Magazine</u>!

Teens and stress: When it's more than worry

Listening to music or setting aside alone time can help teens manage stress.

Advice to help adolescents cope with anxiety and other mental health struggles

Stress—and sometimes feeling anxious is a natural and normal experience for everyone, including children and teenagers. But when those feelings last a long time or occur frequently, that's cause for concern.

According to Krystal Lewis, Ph.D., a licensed clinical psychologist in the National Institute of Mental Health Intramural Research Program, it's important to <u>know the difference</u> between stress and anxiety. Stress is the body's reaction to danger or excitement, including about positive things such as an upcoming party or a vacation. Stress causes the body to release hormones that can raise blood pressure, heart rate, or blood sugar.

Anxiety is the body's or mind's response to stress, even when there are no current stressors. Dr. Lewis said this often comes from the fear of a future outcome that may not even happen. For example, you may be worried about getting into college or an important exam: "You already had the test, but you're still feeling anxious...You're worried about the next test now."



If you think a teen is experiencing a mental health crisis, the **988 Suicide & Crisis Lifeline** is a **national, 24/7 hotline** that can connect you with a trained crisis counselor by phone or online chat. TTY users can contact the Lifeline via their preferred relay service or by dialing 711, then 988.

She said it's important to remind adolescents that it is normal to feel pressure to be perfect or perform well. However, failure is a part of life. If a teen is so concerned with not making mistakes that anxiety gets in the way of them enjoying life or causes prolonged physical symptoms, that could become a clinical problem.

Physical symptoms of stress and anxiety include headaches, trouble sleeping, digestive issues, or muscle pain. If left untreated, these symptoms can damage the body and lead to other mental health issues, including anxiety disorders.

A mental health professional can diagnose an anxiety disorder, which may require <u>treatment</u> such as therapy or medication.

We don't know what causes anxiety disorders, but risk factors include a family history of the condition or other mental illness and a person's brain biology and chemistry. Some physical health conditions such as thyroid problems or arrhythmia can also lead to anxiety disorders. Experiencing traumatic events is a risk factor as well.

For adolescents, stress and anxiety can be hard to talk about. Some signs that a teen is struggling may include noticeable changes in appetite and sleep,

At-home stress coping strategies for teens

A teen's environment can contribute to them developing an anxiety disorder, so in addition to exploring treatment options, it's important to take simple steps to decrease their risk.



Sleep. Make sure they are getting enough! Eight to 10 hours of sleep per night are recommended for teens ages 13 to 18. Stick to a regular bedtime and make their sleep space as calm as possible.



Physical activity. This can be gentle, such as yoga or walking, or more intense, like running or playing team sports. Exercise causes the body to release endorphins, which are hormones that can relieve pain and reduce symptoms of anxiety. It also helps take their mind off whatever is causing them stress.



Balanced diet and hydration. Eating regular, healthy meals and drinking plenty of water can improve energy and focus throughout the day. They may want to limit caffeinated beverages such as soft drinks or coffee and other foods that can cause physical symptoms of stress or discomfort.



Meditation and breathing exercises.

These don't have to be complicated or take a lot of time. They can spend a few minutes being still and quiet, listening to their breathing, and letting their mind clear. They can also download a mobile app or listen to meditation playlists to guide them in a relaxation exercise.

aggression, irritability, difficulty concentrating, avoiding social activities, and engaging in self-harm or having thoughts of suicide.

Having a schedule or routine is also important for adolescents. Sometimes it's less about creating a schedule and more about modifying the schedule you already have.



Teens experience stress and anxiety, but talking about it with parents and teachers can help.

"Schedules are useful in that they help create a routine and give them something to look forward to," Dr. Lewis said. "When you're able to create a schedule and you know what's upcoming, that can help you to manage stress and anxiety by minimizing the unknown."

Just make sure that schedule also includes time for fun and relaxation!

Resources and hotlines for teen mental health

- <u>TrevorSpace</u>. Online chat community, forums, and resources for LGBTQ+ youth, moderated by <u>The</u> <u>Trevor Project</u> nonprofit staff. The organization's website has a "quick exit" safety feature: Users can press their ESC key three times and it will exit the site as well as erase it from their browsing history.
- Disaster Distress Helpline. Operated by the Substance Abuse and Mental Health Services Administration, this 24/7/365 helpline provides disaster crisis counseling for experiences such as natural disasters, health emergencies, incidents of mass violence, and the anniversaries and trigger events of those experiences. Users can call toll free or text 800-985-5990. This service is confidential and multilingual.

"When you're able to create a schedule and you know what's upcoming, that can help you to manage stress and anxiety by minimizing the unknown."

> -Dr. Krystal Lewis, licensed clinical psychologist at the National Institute of Mental Health

Other resources



- Children and Mental Health: Is This Just a Stage?
- <u>Helping Children and Adolescents Cope With</u>
 <u>Traumatic Events</u>
- I'm So Stressed Out!
- Let's Talk About Eating Disorders
- <u>The Teen Brain: 7 Things to Knows</u>
- <u>Caring for Your Mental Health</u>

Teens are talking about mental health

High schoolers' stories give a glimpse into the national crisis

he prevalence of mental health issues is hard to measure, but federal data show how widespread the challenges are. The Centers for Disease Control and Prevention (CDC) said we need to address threats to mental health in young people—especially adolescents.

More than one third (37%) of high schoolers in the United States reported experiencing poor mental health during the COVID-19 pandemic, according to a 2021 <u>CDC study</u>. Almost half (44%) of high schoolers reported feeling persistently sad or hopeless in the last year. Some of these feelings were also linked to experiences of racism, social stigma around gender and sexual identity, and sexual violence.

Studies like these can help shed light on issues that teens may be hesitant or unable to discuss with <u>parents, doctors</u>, and school staff.

Stigma and a lack of information or access to care also keep many teens from getting help. But sharing personal stories about mental health can offer encouragement and connection. This can help teens feel like they are not alone. That's why NIH asked high schoolers to describe these challenges in their own words for the <u>2022 Speaking Up About Mental Health!</u> essay contest.

FAST FACT

In 2018–2019, among adolescents in the United States ages 12 to 17, **15.1% had a major depressive episode**.

SOURCE: CENTERS FOR DISEASE CONTROL AND PREVENTION

According to the Centers for Disease Control and Prevention, in 2021:

- 36% of high school students perceived or experienced racism before or during the pandemic
 - Asian (non-Hispanic): 64%
 - Black (non-Hispanic): 55%
 - Multiracial (non-Hispanic): 55%
 - Hispanic or Latino: 42%
 - American Indian/Alaska Native (non-Hispanic): 27%
 - Native Hawaiian/Pacific Islander (non-Hispanic): 55%
 - White (non-Hispanic): 23%
- 18% of female high schoolers and 5% of male high schoolers experienced sexual violence
 - Up from 15% and 4%, respectively, in 2017
- 57% of female high schoolers and 29% of male high schoolers had persistent feelings of sadness or hopelessness
 - Up from 41% and 21%, respectively, in 2017
- 69% of lesbian, gay, bisexual, and questioning (LGBQ+) high schoolers* and 35% of heterosexual students had persistent feelings of sadness or hopelessness
 - 14% of LGBQ+ high schoolers and 7% of heterosexual students did not go to school because of safety concerns

*Although this data set did not account for gender identity, previous research has shown that transgender youth experience more stigma and are more likely to have more suicidal thoughts or behaviors compared to their peers.

SOURCES: Centers for Disease Control and Prevention; Morbidity and Mortality Weekly Report Supplement, Vol. 71, No. 3; CDC report shows concerning increases in sadness and exposure to violence among teen girls and LGBQ+ youth; LGBQ+ Teens

MENTAL HEALTH



"I was also having issues with my friendships at school and an increased level of stress when it came time for tests, projects, and other assessments ... the feeling of isolation, lack of appetite, and absolute hatred of school were not normal."

- Morgan, New Jersey



"That young, fragile boy seemed so mentally strong. He knew how to get out, how to solve problems ... I now realize that a teenager's plights and a child's plights are usually very different."

- Melvin, Massachusetts

The contest was sponsored by the National Institute of Mental Health (NIMH), the National Institute on Minority Health and Health Disparities (NIMHD), and the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD). They wanted to start conversations around youth mental health and highlight different aspects of this national health crisis.

In their essays, many students talked about feeling lost, embarrassed, or frustrated by their mental health struggles. Others wrote about going from being confident in early childhood to feeling alone or unseen in adolescence.

NIH-funded researcher Tamar Mendelson, M.A., Ph.D., Bloomberg Professor of American Health and Director for the Center for Adolescent Health at the Johns Hopkins Bloomberg School of Public Health, says that's not surprising. Depression rates tend to increase around puberty, especially among girls but also in boys. Dr. Mendelson said this can be caused by a combination of hormonal changes, new social relationships, and new pressures from academic, athletic, and other activities. "Young people who are feeling overwhelmed or are not sure how to cope with emotions may be more likely to use substances to kind of help with that," Dr. Mendelson said. Such substances could include alcohol, tobacco, or prescription or illicit drugs.

Puberty is also when many young people become more aware of their sexual orientations and gender identities. For some, this can lead to being unaccepted or bullied. Rates of substance use and misuse also tend to increase during puberty.

In addition to navigating the typical stressors that teens face, they've recently had to cope with the COVID-19 pandemic and related family losses or financial struggles. They've experienced or witnessed racial- and identity-based discrimination, gun violence, political unrest, natural disasters, and climate change. These challenges, coupled with other risk factors, including some parenting styles, can lead to mental health issues such as anxiety and depression.



"Since I started high school in an LGBTQaccepting school where LGBTQ issues are discussed and antidiscrimination measures are taken, my depression has decreased significantly."

<u>– Leila, Ohio</u>



"For many Asian American youths, getting help for mental health can be hindered by stereotypes. Asian American boys, in particular, may not seek therapy since their cultures expect them to be more resilient than girls. After all, as the older brother, how can I let my little sister know when I am not feeling well emotionally?"

— Evan, Texas

MENTAL HEALTH



"By changing the way eating disorders are taught in all school levels, it is possible to change the false assumptions the public often has about individuals who struggle with eating disorders."

— Evelyn, Virginia



"After [my cousin's] diagnosis, he was subjected to ever-changing medications until they found one that numbed his emotions while still allowing him to function. Finding the right therapist required being put on multiple waitlists, and several therapists didn't accept insurance."

— Rohan, California

Even though environmental triggers have changed over time, adolescent anxiety was rising even before the pandemic.

Michele Ybarra, Ph.D., an adjunct professor of mental health at the Johns Hopkins Bloomberg School of Public Health as well as an NIH-supported researcher, said that not long ago, it was widely believed that youth could not have depression because people thought, "What do [they] have to be depressed about?"

But in the last several decades, Dr. Ybarra said, mental health professionals have realized that depression can happen to anyone at any age.

Several students wrote about schools with limited, outdated, or no education on the topic. Some said they could not speak to a therapist or school counselor when they needed to.

The issue is worse for students in <u>rural areas</u>, in schools with limited financial resources, or who need culturally appropriate care such as bilingual mental health information.



If you think a teen is experiencing a mental health crisis, the <u>988 Suicide & Crisis Lifeline</u> is a **national**, 24/7 hotline that can connect you with a trained crisis counselor by phone or online chat. TTY users can contact the Lifeline via their preferred relay service or by dialing 711, then 988. But <u>digital tools</u> can connect youth to information about their mental health. For example, Dr. Ybarra said, the rise of telehealth and teletherapy since the pandemic has helped increase access for some.

Dr. Ybarra said that while technology (including social media) can have both positive and negative effects on mental health, it can also be a force for good. The nature of relationships has changed in the internet age, and <u>connecting online is natural for adolescents</u>. Options like crisis lines or online therapy can get help to teens quickly.

Multiple students said when they could not find resources from their schools or communities, they started their own. Some also said their experiences have inspired them to study mental health and treatments after high school.

One student said they <u>began volunteering for a teen</u> <u>crisis hotline</u> after a relative used the same service for help. The student also joined a youth advisory group for their state governor's office and offered help as a peer-to-peer counselor at their school.

"My passion towards becoming a researcher on psychiatric disorders is stronger than ever," they wrote.

The way people talk about mental illness could also be better, <u>one student wrote</u>. They preferred the phrase "living" with a mental illness rather than "suffering" from one. This small change in language signals it's possible for people with such conditions to live happy and fulfilling lives. This student also said their own school began marking mental health-related absences as excused and holding an annual mental health week to encourage open conversation.

Get the full story and learn about NIH-supported research on adolescent mental health online at <u>NIH MedlinePlus</u> <u>Magazine</u>!

Meet the Director: **NIH**



National Institute on Minority Health and Health Disparities



Eliseo J. Pérez-Stable, M.D.

Eliseo J. Pérez-Stable, M.D., served in the medical and research communities for decades before becoming the second Director of the National Institute on Minority Health and Health Disparities (NIMHD) in 2015. His path to NIH was guided by his unique experiences and partnerships, which prepared him to lead NIMHD in its mission to reduce health disparities and improve the health of minority and disadvantaged populations.

He also oversees his lab at the National Heart, Lung, and Blood Institute (NHLBI), where his research explores health differences among racial and ethnic groups and how social factors such as migration and the environment affect health.

Dr. Pérez-Stable shared highlights from his career and discussed advancing the science of minority health and health disparities with NIH MedlinePlus Magazine. He talked about NIMHD's unique role within NIH, how the landscape for health disparities research changed with COVID-19, and what he's most excited about moving forward.

Can you tell us about your background and what brought you to this field?

I was born in Cuba, and I spent the first eight and a half years of my life there. After the Cuban Revolution, my parents decided that they didn't want to risk staying there, so in 1960, we immigrated to the United States. I guess my journey starts there because as a Cuban American, I'm an immigrant and I'm a minority individual. We moved to Pittsburgh, where I learned English.

The second big thing is that I became a physician. My father was a physician, but he never really pushed it on me. I think I opted for medicine because it was a noble profession and I would always have a job.

I was originally a history major in college, and I always had a strong interest in politics and current affairs, particularly around Latin America but in the United States as well. I quickly realized if I wanted to be a physician-and a good one—I wouldn't have time for much else. Medical residency brought me to the West Coast, and I went to the University of California, San Francisco (UCSF), for training in primary care general internal medicine. I fell in love with the area and lived in San Francisco for 37 years, where I built my career.

Can you describe your career progression from clinical practice to research?

I learned research methods during a two-year [clinical] fellowship, which turned me on to academic research. There were people around me who encouraged and supported me. Dr. Steve Schroeder [Director of the UCSF Division of General Internal Medicine] was a mentor and my first boss at UCSF. He was an influential leader in general internal medicine, which didn't really exist in many academic centers at the time.

I began to collaborate with behavioral and social scientists. I worked first on depression prevention in primary care and in tobacco use and smoking cessation among Latinos, and then moved more toward population science.

A lot of my clinical work had very little to do with my research. I got funding from NIH very early on, but I also really enjoyed my role as a leader in research and as a clinician, a generalist, and an educator at UCSF.

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How did you first become interested in minority health and health disparities?

My interest in minority health began in my third year as a resident when all of the residents in my year were asked to do a talk [on a topic of our choice]. I did two: one on Cuba and one with another resident on cultural factors in communicating with patients who are American but not White. I focused on Latinos, and the other resident, who is Vietnamese American, focused on Southeast Asians.

That was the beginning of my thinking about, "What is it about me being Cuban and able to speak Spanish that made it different [for me] to take care of these patients who did *not* speak English?" An obvious thing was language, but I felt there was something else going on, and I wanted to study that. I called it "cultural factors" in communicating.

I followed a path in academics that was not traditional. I never spent time in a lab or worked with animals. I didn't focus on a narrow area and become an expert in that area. I was an expert in minority and Latino health. It wasn't specific to just one topic.

How did that interest shape your career path?

Once I became an associate professor at UCSF, my role became more defined, and I started to connect with others and do more collaborative work. I went from mostly working only on my own projects to now having networks, both local and national, which created the platform to make progress in my research. I partnered with Dr. Eugene Washington, who worked in a similar role to mine in the UCSF obstetrics and gynecology department. Gene is African American and got grant funding to create what we named the Medical Effectiveness Research Center for Diverse Populations (now called the Multiethnic Health Equity Research Center). It was the first center for minority health research at UCSF. We had different clinical backgrounds and were connected to different people. Combining forces was a huge step in the right direction in terms of what we were able to accomplish at UCSF.

Because we were focused on minority health, we attracted people from different disciplines. A pediatrician who was interested in studying birth outcomes by race and ethnicity

What are determinants of health?

Determinants of health are the various factors that influence a person's overall health and well-being and include social, structural, biological, behavioral, and health care system influences. Recent findings from research supported and conducted by NIMHD highlight the importance of these determinants. Examples include:



Geographic location.

Residents of rural counties in the United States are <u>more likely to die</u> <u>from diabetes</u> than those living in urban areas. This shows that health disparities are not limited to race or ethnicity but also extend to geographic location and access to health care.



Systemic racism.

A study conducted by NIMHD researchers found that <u>Black college</u> <u>students reported better mental</u> <u>health outcomes</u> when their school's administration acknowledged institutional racism on campus and took steps to address it.



Access to health care.

A study supported by NIMHD found that pregnant women were more likely to receive treatment for gestational diabetes if they were enrolled in Medicaid.

came to me and said, "I want you to be my mentor." I was an internist, and I didn't have any experience with kids at the time. I said, "Tell me how I can help you." It turned out that she trusted me, and I knew about Latino health, and she taught me about the issues she was interested in. I realized I could be a mentor for someone in a different discipline, and I never again accepted the excuse (that I still hear), "I'm not an expert in that area so I can't say anything about it."

To read Dr. Pérez-Stable's path to NIMHD and what he finds most challenging and motivating in his role as Director, check out his full interview online at NIH MedlinePlus Magazine!



Dr. Shuai Xie is building a bridge between engineering and public health

As an engineering student, she studied how indoor building materials may contribute to indoor air pollution. Now she uses her training to discover how pesticides used outdoors may enter homes, particularly in agricultural areas.

s a postdoctoral fellow at the National Cancer Institute (NCI) <u>Occupational</u> and <u>Environmental Epidemiology</u> <u>Branch</u>, Shuai Xie, Ph.D., M.P.H., collaborates with experts in exposure science and cancer epidemiology to explore pesticide exposure among farmers and their families. Her research, which uses data from the <u>Agricultural Health</u> <u>Study</u> (a government-funded study about health in farming populations), could improve our understanding of how pesticides enter homes.

To evaluate exposure to indoor pollutants such as pesticides, researchers collect and analyze dust samples from inside people's homes and test them for pesticide residue. Dr. Xie compares pesticide measurements from these dust samples to the farmers' responses to a questionnaire. She looks at the number of days the farmers reported using different types of pesticides and other information about work practices and home habits and characteristics. If she finds a strong relationship between them, scientists and public health professionals could use similar questionnaires to estimate potential levels of pesticide exposure within a home. This could save time and reduce some of the logistical challenges of collecting and analyzing dust samples.

Dr. Xie spoke with NIH MedlinePlus Magazine about how her research connects engineering and public health.

How did you first become interested in environmental health?

[In my engineering Ph.D. program,] my research focused on measuring how indoor building materials adsorb pollutants (adsorption is when a substance gathers or accumulates on a surface) and release them. I studied *trichloroethylene* (a volatile liquid chemical that can cause kidney cancer). Trichloroethylene can be found in indoor and outdoor air and in the airspaces of contaminated soil. I collected things like carpet, dust, and drywall and did experiments to measure their adsorption capacity—how much of the chemical gathers on their surfaces.

Studying the indoor environment and seeing the detectable measurements made me feel like our living environments could potentially impact our health. I became interested in environmental and occupational health and wanted to understand how to measure indoor contaminants and identify where they come from. In doing that, I worked with epidemiologists to understand if those exposures may impact our health.

How do you use your chemical and environmental engineering skills in your current research?

In my current work at NCI, we are looking at pesticide levels adsorbed in house dust in farming communities. Dust samples are collected from vacuum cleaners and analyzed by a laboratory. My job is to interpret those measurements. I use statistical models to link them to pesticide information provided by the farmer. My goal is to understand how a farmer's pesticide use outside the home contributes to pesticide concentrations inside the home.

I feel like my current work is a bridge between my training in engineering and public health. [My engineering background] helps me understand the lab report quickly. I know the instruments they used and the basic ideas behind the analysis, even though I didn't do it myself.

I also know the limitations of the lab technologies. As engineers, we measure samples and get a number, but we don't always know how to best interpret it. Engineering on its own cannot explain if that number means there is a risk for people. As a multidisciplinary team of exposure scientists and epidemiologists, we collaborate to interpret the findings as they relate to public health.



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Why is this work important for public health?

People mostly think about farmers getting exposed to pesticides because they have a lot of direct contact [in their work]. But research also shows that the dust in their houses has higher pesticide levels than the dust in non-farming houses. This means that other people who live on the farm—their spouses, their children—may also have potential pesticide exposure even when they are not directly participating in farming activities. Their exposure to pesticides also needs to be studied.

We also want to know where those chemicals are coming from. When the farmers work in the field, do they bring [the pesticides] home with them? We are exploring how their activities at work and at home may contribute to indoor pesticide concentrations. This includes how frequently they use pesticides, how old their carpets and homes are, and if the farmers take off their shoes before coming inside their houses.

My research focus is on measuring the amount of a contaminant that's in a home and evaluating factors that might influence those levels. My work can be used by other researchers to help identify possible mitigation strategies (changes that minimize or prevent risk).

ENVIRONMENTAL HEALTH



"Other people who live on the farm—their spouses, their children may also have potential pesticide exposure even when they are not directly participating in farming activities."

Are there any early findings or takeaways that you can share?

Generally, we found that the more a farmer uses a pesticide, the higher the concentrations of it are in their homes. Houses that are near fields treated with pesticides also have higher pesticide concentrations than ones that are farther away.

We also found other activities that can be related to higher pesticide concentrations in homes. These include when they use a pesticide within the home (for example, to treat ants or termites), on their cats or dogs (as in flea and tick treatments), or in their yard (to treat insects and weeds).

What part of your research are you most excited about?

First, I enjoy doing research at the intersection of engineering and public health. Engineering and public health are quite different disciplines, and the link isn't always obvious. Working in exposure science makes me feel like I can apply what I've learned from both disciplines and bring them together. There are a lot of challenging questions in [exposure science], and it's exciting to learn skills that I can use to help answer them.

How has your research changed your behavior at home?

In my Ph.D. program, I measured how much trichlorethylene could be adsorbed in different building materials. Even though they were only found at low levels, it makes me more cautious. I clean much more frequently than I used to. It makes me cautious about the chemicals that I choose to use in my home as they may stick to our furniture and building materials.

What is your favorite thing about working at NCI?

NCI is a very supportive, interdisciplinary-friendly environment. There is a lot of collaboration across different groups—it is a great place for trainees to learn from many different perspectives. I've learned how to work with multiple collaborators on the same project. It's not hierarchical—we call each other by our first names.

At NCI, I get a lot of support from my mentor [Senior Investigator] Melissa Friesen, Ph.D. She taught me so much about exposure science, and she really cares about me not only as a scientist but also as a person. She cares about my ideas and what direction I want to go with my career. She understands how important this career stage is [for young researchers].



Engineer and athlete Rory Cooper, Ph.D., draws from personal experience to design new technologies for people with disabilities

Dr. Rory Cooper, Director of the Human Engineering Research Laboratories at the University of Pittsburgh.

R ory Cooper, Ph.D., is a Paralympian, Army veteran, world-renowned inventor and engineer, and disability advocate. In 1994, he founded the <u>Human</u> <u>Engineering Research Laboratories (HERL)</u>, a collaboration with the University of Pittsburgh and the U.S. Department of Veterans Affairs (VA) Office of Research and Development. HERL has advanced engineering and clinical research for mobility impairments around the world.

Dr. Cooper and HERL's work empowers people with disabilities through innovative technology. While talking with NIH MedlinePlus Magazine, Dr. Cooper told us about his contributions and why accessibility matters to those with mobility challenges.

What is the purpose of HERL? How does the lab give back to those with disabilities?

Everything we do is meant to give back to and improve the lives of people with disabilities. The whole purpose of HERL is to advance engineering and clinical research for their rehabilitation and community living. We give back through the technologies we create, the results we generate, and educational materials and programs. We work to change policies and practices for resources such as Medicare or for VA coverage. Most importantly, we've trained people with disabilities or people who have family members with disabilities who are passionate about our mission. We've used their knowledge to improve both products and health care.

I thought it would be unique and effective to create a lab or center where different academic disciplines worked together as a team on a shared mission and maybe make a greater impact.

The creation of HERL, the people that we've trained, and the lives of the people with disabilities that we've positively influenced are my proudest contributions. We've done several things that have made a significant impact, including creating the first powered wheelchair that is entirely submersible to make water parks more accessible. We also created a more useful computer mouse for people who use prosthetic hook end-effectors. We've contributed to several global wheelchair design standards.

[Thanks to HERL's work,] millions of people have independent mobility again.

I started HERL because I also have a disability. When I started doing wheelchair sports [after leaving the Army], specifically basketball in college, I saw a lot of the challenges that people with various disabilities were facing. I knew there was a potential for technology to help improve mobility and function.

What inspired you to try adaptive sports? Can you describe your experience as a Paralympian?

I became involved in the Paralympics because of running. I started running in the fifth grade, I think, and I enjoyed the sport. I wasn't quite sure that I would make the Olympics, although when I joined the Army and started running, I became faster. If I hadn't been injured [during my Army service in 1980], I may have had an opportunity. After taking up adaptive sports, I fell in love with wheelchair racing, hand cycling, and swimming. I focused on wheelchair racing because of the technical and athletic aspects. There was a growing interest in wheelchair racing among people with disabilities at the time, so there was a lot of innovation and competition.

My experience as a Paralympian was awesome. I first competed in 1988, and I was very fortunate to be in the first Paralympics that used the same facilities and venues in Seoul, South Korea, as the Olympic athletes. That was amazing. Asia is a continent that really embraces the Paralympics, and they've always done a wonderful job. And for that, I'm fortunate. I've since been a coach and an organizer or member of several committees for Paralympic teams.

One of the greatest experiences was making connections. I made friends through training and competing in the Paralympics, even from teams of other countries. They're still friends of mine all these years later. It wasn't just a once-in-a-lifetime experience—it turned out to be a lifelong experience.

What current research or innovations is HERL working on?

We're excited that we have several projects related to robots. We have robotic manipulators (similar to arms) for mobility and for improving independence to perform daily tasks such as making meals, cleaning up, and eating. And we're developing a robotic wheelchair for crossing over uneven surfaces. The lab is also working on new prosthetics and new systems to help prevent or reduce the risk of pressure injuries and other seating-related disabilities. We have about 50 ongoing projects.

To learn more about Dr. Cooper's accessibility engineering research and to watch his talk as part of the NIH Director's Wednesday Afternoon Lecture Series, find his full interview online at <u>NIH MedlinePlus Magazine</u>!

"I made friends through training and competing in the Paralympics, even from teams of other countries. They're still friends of mine all these years later."

Dr. Rory Cooper, bottom, at the start of the 2022 Army Ten-Miler Race in Washington, DC.





An example of a modern bionic prosthetic arm.

illions of people in the United States are currently living with limb loss. This number is expected to grow as the population ages and rates of diseases such as diabetes that can cause dysvascularity (poor blood circulation in the legs) increase.

For people with limb loss, prosthetic devices improve quality of life by providing movement and independence. Early prosthetics were uncomfortable to wear, but they may have help people return to work and feel accepted in ⁺' daily lives. We'll explore how these devi changed over time, from clunky, early desig and materials to modern innovations—some c. which NIH-supported researchers are developing.

When were prosthetics invented, and what were they used for?

Historians don't know for certain if the first prosthetics were functional or for appearances. According to Katherine Ott, Ph.D., curator for the Division of Medicine and Science at the Smithsonian Institution's National Museum of American History, this is partly because different cultures have their own ideas about what makes a person whole.

Prosthetics through the ages

A look at how prosthetics have changed over time and how NIH supports innovation

The oldest known prosthetics are two different artificial toes from ancient Egypt. One prosthetic toe, known as the "Greville Chester toe," was made from cartonnage, which is a kind of papier-mâché made from glue, linen, and plaster. It is thought to be between 2,600 and 3,400 years old, though its exact age is unknown. Because it doesn't bend, researchers believe it was cosmetic.



A wood and aluminum prosthetic arm invented by William Robert Grossmith in the mid-19th century.



An artificial leg from the American Civil War.

The other prosthetic, a wooden and leather toe, known as the "Cairo toe," is estimated to be between 2,700 and 3,000 years old. It is thought to be the earliest known practical artificial limb due to its flexibility and because it was refitted for the wearer multiple times.

Approximately 300 years later—300 B.C.—in Italy, an ancient Roman nobleman used a prosthetic leg known as the "Capua leg." The leg was made of bronze and hollowed-out wood and was held up with leather straps.

Other known early prosthetics include artificial feet from Switzerland and Germany, crafted between the 5th and 8th centuries. These were made from wood, iron, or bronze and may have been strapped to the amputee's remaining limb.

How war—and the U.S. military inspired prosthetic advances

Soldiers who lost their limbs in battle often used early artificial limbs made of wood or iron. For example, about 2,200 years ago, the Roman general Marcus Sergius Silus lost his right hand during the Second Punic War. He had it replaced with an iron one that was designed to hold his shield. Knights of the Middle Ages sometimes used wooden limbs for battle or to ride a horse. And in the 16th century, the French surgeon Ambroise Paré designed some of the first purely functional prosthetics for soldiers coming off the battlefield. He also published the earliest written reference to prosthetics.

Then came the American Civil War in 1860. The record number of amputees from the war caused the number of patents for prosthetics to almost quadruple. One of these patents was for a wooden leg called the "Hanger limb." It was the first to use rubber in the ankle and cushioning in the heel, showing that inventors understood they needed to make prosthetics less painful for amputees to wear.

Today, the U.S. Department of Veterans Affairs is a major provider of prosthetics and a leader in rehabilitation treatments for veterans who lose their limbs during their service. These patients are at risk for polytrauma, meaning they have injuries on multiple parts of their bodies, usually from blast-related events.

When this happens, these veterans need multifaceted clinical care and a support network. The <u>Rehabilitation</u> <u>Medicine division</u> at the NIH Clinical Center and the <u>National Center for Medical Rehabilitation Research</u> at the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development help treat prosthetic users and conduct research about limb loss.

Improvements in design

While prosthetics were still made of combinations of wood, metal, glue, and leather even up to the 20th century, they were becoming more functional. From the late 15th century to the 19th century, France and Switzerland were making artificial limbs that could rotate and bend using cables, gears, cranks, and springs. However, these devices still needed to be adjusted manually. For example, an artificial hand could be cranked shut around a fork, but the person still needed another hand to operate the crank.

During the 1900s, manufacturers started to build more functional prosthetics by swapping wood and leather for plastics and other artificial materials. Still, some of the best

A young man having his right leg fitted with a prosthetic leg.





FAST FACT

Due to demand from soldiers injured in the American Civil War, the number of patents filed for prosthetics in the United States went from **34 in 1860** to **133 in 1873**.

> SOURCE: <u>CARE OF THE COMBAT AMPUTEE</u> (BORDEN INSTITUTE)

prosthetics were out of reach for most people, including veterans. Many of these devices were only designed for specific tasks such as piano playing. They would not become more accessible to veterans until World War I, when prosthetic manufacturing for soldiers with limb loss increased in Great Britain. According to Jeffrey S. Reznick, Ph.D., Chief of the National Library of Medicine History of Medicine Division, such wartime manufacturing (and repair) sometimes occurred in military hospitals. Soldiers recovering in those facilities were fitted with artificial limbs as part of their care.

Today's prosthetics look and work very differently from those made before the late 20th century. More lightweight and durable materials such as plastic, aluminum, titanium, and silicone are common in today's prosthetic devices. They also fit closer to the person's remaining limb. The Walter Reed National Military Medical Center will even tattoo service members' prosthetics to help them look and feel more natural.

But what if a prosthetic could move without the person consciously controlling it? That is what the next generation of artificial limb technology aims to do.

NIH-supported innovations in prosthetics

Scientists are developing robotics, <u>3D printing</u>, artificial intelligence, virtual reality, and motion-sensing technologies for prosthetics. Over the last decade, NIH has funded <u>several projects</u> that harness the brain's electrical activity to move prosthetic limbs using electrodes implanted in a person's remaining muscles. These electrodes send signals to the brain and allow the prosthetic limbs to move more freely.

One example of research funded by the National Institute of Biomedical Imaging and Bioengineering is a robotic lower leg prosthesis that creates a more natural walking motion. Researchers at Vanderbilt University created the device with powered knee and ankle joints and with software that can anticipate how the person wants to move.

In addition to these technological advances, it's also important to track how many people use prosthetics and what treatments work best for these patients. That's why NIH, together with the U.S. Department of Defense and the Mayo Clinic, helped create the Limb Loss and Preservation <u>Registry</u> in 2020. This registry uses electronic health records to measure how many people in the United States have limb loss and to understand the costs and treatment outcomes for these patients.



Two men, each with a prosthetic arm, sit at a table and play checkers.

NIH is here to help

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