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ny sniper James Crowell went to war 70 inches tall. He returned home an inch shorter and in constant pain, his spine compressed by the collective trauma of a rocket fall, a plane accident and his heavy body armor; worn a notch every day on the battlefield.

Birdzell spent eight years in the Marine Corps, had a shoulder in the elite Special Operations Command, "running at 8,000 rpms." Racked by insomnia and bouts of intense anger on the battlefield, he discovered that combat stress had wreaked havoc on his hormones.

Jose Villavicencio, a Marine communications specialist, tumbled off a ladder and struck his head as he sought to escape a Taliban mortar barrage in southern Afghanistan three years ago. Since then, he has been suffering from wrenching migraines, bouts of dizziness, spells of intense anxiety and memory loss.

Michael Meyer, a former Air Force staff sergeant, inhaled lungful after lungful of acrid smoke as he followed orders to shoot scavenging birds inside a cavernous pit of burning trash on a base in Afghanistan. Now he's back home in Nevada, and his lungs are failing. He lives his days tethered to an oxygen tube.

Because their injuries were not the direct result of an enemy attack, Crowell, Birdzell, Villavicencio and Meyer were not awarded Purple Heart medals, nor do they show up in the Defense Department's tally of nearly 62,000 service members wounded in action in Iraq and Afghanistan. But their ailments, and similar non-hostile injuries suffered by legions of fellow soldiers, have become a profound and enduring consequence of the wars.

"War is brutal on the body," said Crowell, a sergeant first class who was stationed in some of the most dangerous parts of Iraq and Afghanistan. "I'll feel it in my back for the rest of my life."

Of the 2.6 million service members dispatched to fight the wars in Iraq and Afghanistan since 2001, more than half say their physical or mental health is worse than before they deployed, according to a poll conducted by The Washington Post and the Kaiser Family Foundation (http://www.washingtonpost.com/page/2010-2019/WashingtonPost/2014/03/30/National-Politics/Polling/release_305.xml). But most of these health problems are not the result of gunshots, grenades and roadside bombs: Almost

t in 10 of those reporting health problems - about 1 million of them - say they were not seriously injured in combat.

er wounds stem from the chaos and grind of modern war, the cost of saddling one's frame with a bulky armored vest and extra clips of ammunition, the failure to provide basic safety gear, mistakes that occur when hulking vehicles are driven by sleep-deprived troops, the eardrum-ringing blasts of gunfire and artillery. During the entire Iraq war, which stretched for almost 8 years, the military conducted more medical evacuations by air for troops who had non-lethal wounds than those injured in combat.

Post-Kaiser survey found a deterioration of physical health in 43 percent of veterans and worsened mental health in almost a third. Among those who served in combat jobs, the changes were even more significant: 56 percent say their physical health is worse, and nearly four in 10 say their mental health has slipped. Rates of health problems are significantly higher in those who served for three or more years.

The poll is roughly in line with other research on the health consequences of the wars. A 2008 study of soldiers in two combat brigades who deployed to Iraq for a year found that one-third had been physically injured and that almost 44 percent met the military's criteria for post-traumatic stress.

In many cases, non-combat injuries have not impeded veterans from continuing their military careers or pursuing fulfilling civilian lives. And they recognize that their wounds can seem like paper scratches compared with those of comrades who have lost limbs or eyes or are suffering from a severe traumatic brain injury.

But their ailments nonetheless can be life-altering - chronic pain, fits of anger, sleeplessness, constant ringing in the ears - and have added to the ongoing cost of the wars. Of those no longer serving in the military, 45 percent have sought compensation for service-related disabilities, according to the Department of Veterans Affairs. Thirty-seven percent of them have been deemed disabled enough to receive lifelong payments, a figure that could increase as the department wades through a mountain of unprocessed claims.

For Iraq and Afghanistan veterans may not feel the impact of their service for years. For those

fought in the last century's major wars, requests for disability care and compensation did peak until three decades after the conflicts ended. "The burden borne by wounded warriors their families, and thus the public responsibility to treat or compensate them, will persist for y years," the Institute of Medicine, the health-care arm of the National Academy of Sciences, ned in a 2010 report.

Iraq and Afghanistan conflicts may have their own unique health legacy. Thousands of ps who walked away from roadside bomb blasts, because of luck or mine-resistant trucks or l, may nonetheless have suffered moderate brain injuries that could cause long-term health sequences.

don't yet know the extent" of the health effects of the traumatic brain injury, said David , the VA's national director of physical medicine and rehabilitation, who is leading a large onal study that aims to measure the impact of battlefield concussions over several decades. iminary research, he said, suggests that troops exposed to persistent stress - as tens of isands were in both wars - may be more susceptible to lasting damage from brain injuries.

y're more vulnerable because they never had a chance to heal," Cifu said.

1 for those who do not claim to be injured, the wars have exacted a discernible physical toll. Army assessment found a spike in cases of high blood pressure and elevated heart rates ng incoming majors at the U.S. Army's Command and General Staff College at Fort wenworth, Kan., most of whom are in their early 30s but have had multiple combat oyments. "Many of them were testing a decade older than they were," said a senior Army er who had been at the college when the tests were conducted and spoke on the condition of ymity so he could discuss the issue candidly. "It was the stress and strain of combat."

sed to be quite blunt with them," he said. "I told them, 'Unless you sleep better, eat better exercise more, you're not going to have the life expectancy of an average male or female.' "

ing with a busted back

:30 on a chilly Saturday morning, Jim Crowell pulled on a drab green cap, zipped up a gray lbreaker and ambled onto the empty winter-browened parade field next to his barracks at

Benning, Ga. With no mandatory physical training on weekends, he could have slept late in a warm room or joined his fellow soldiers in the chow hall. But Crowell, 32, afforded himself dispensation.

He bent forward slowly, his fingers inching toward the ground. His back tightened. Muscles ached. Joints creaked.

If he stayed inside, if he took the day off, he'd feel it later that morning. A sharp pain would radiate in his lower back, radiating down his leg.

"I can't take 25 percent of my day," he said as he switched to a series of bend-and-reach exercises, starting with his arms raised over his head and ending with them touching the ground. "I won't be able to focus. My attention span will be zero."

The pain began almost 11 years ago, on a sweltering summer night in south Baghdad. He and a fellow soldier from the Army's 82nd Airborne Division had been skulking across rooftops, tracking insurgents through their night-vision goggles, when his Kevlar helmet, imbalanced by the weight of his scope, slid down over his face. Crowell fell backward, sliding off the roof and landing in a garbage can in the alleyway below.

He picked himself up and kept on moving, worried that a call for help would reveal his location to the insurgents. When he got back to his base the next day, he brushed off a visit to the medical clinic. He figured the discomfort would go away.

It faded, for a while. Then, a few years later, it came raging back.

Crowell didn't want to pop pain pills, so he cobbled together his own solution. Army-regulation sit-ups and leg-lifting stretches mixed with yoga and tai chi poses he taught himself by watching videos on the Internet. And a few unorthodox moves.

He placed his hands behind his back and pulled them down firmly. His back cracked once, then twice.

"It's not that much better," he sighed. "Maybe it will lead to arthritis, but I need relief."

stood up straight.

"I like I'm 69½ inches tall now."

He sat down, legs apart, and crawled his fingers toward his yellow-soled New Balance sneakers. His quadriceps began to sting.

"Only it was just the roof," he said. "That was only the beginning."

After the roof fall, in 2004, he volunteered to join a unit heading to Ramadi, then one of the most dangerous parts of Iraq. And once again, night-vision goggles led to a battering.

While riding in the back of an Army truck at night when the driver became disoriented by a flash of light. The truck careened into a ditch. Crowell fell backwards and jammed his back on a metal pole used to mount machine guns. This time when he returned to his base, he went to see the medics.

The medic said: 'Oh, you're good. You're fine.' "

Physical therapy might have helped, but Ramadi wasn't the place for it. He regularly had to strap on 80 pounds of gear: his flak vest, a helmet, a rifle, water and 10 magazines of ammunition because in Ramadi, you got into firefights every day."

When he returned to the United States, a military doctor told him that he had fractured two vertebrae in his lower back. Post-traumatic stress, fueled by the death of a platoon-mate, had fried his short-term memory and left him prone to fits of rage. Migraines sparked by blast-induced brain trauma flattened him for hours at a stretch.

Physical therapy and counseling helped. As did sudoku puzzles. He took up sewing and spent more time pencil-sketching aircraft. But it's all for naught if he doesn't hit the field in the morning.

He twisted his back to the left, then to the right. His back popped a third time. A deep breath in; as the rising sun cast long shadows over the field, he assumed a plank pose.

"The Army puts another 10 years on you, whether you like it or not."

ty minutes and several stretches later, he pronounced his back "as good as I'm going to get. Not perfect. Not by far. When he sits, he has to slouch to reduce the pain. If he sits too long, he will fall asleep.

ficulty becomes the norm," he said as he walked back into the barracks. "But it could be worse."

mind wanders to two other noncommissioned officers in the leadership course he is attending at Benning. Both lost legs in bomb blasts. He thinks of a squad-mate in the 82nd Airborne who was struck by a rocket-propelled grenade in Baghdad.

ot worse."

ing body chemistry

he needles slid into his ankles, Billy Birdzell sucked in a puff of air. "Wow. That was a good one."

Duggan, his silver-haired acupuncture therapist in Columbia, Md., nodded and walked to Birdzell's side, brandishing two more pins. Duggan pushed one into Birdzell's left pectoral. Then she pushed the other into the right.

"Are you okay with those?" Duggan asked.

"It opens me up," Birdzell replied.

peaceful."

It has been an elusive state for Birdzell. When he got out of the Marine Corps in 2009, he couldn't sleep. He felt hazy during the day. He picked fights at the slightest provocation. His mind raced with thoughts of war. His back and knees throbbed.

A doctor diagnosed post-traumatic stress disorder and told him to see a psychologist. Birdzell was doubtful. He had been through a grueling years in the Marines, including combat deployments to Iraq. But he questioned whether the source of his anger and insomnia was rooted

more than his brain's software. Was it, he wondered, a hardware problem?

brother urged him to have his hormone levels checked. So Birdzell spit into four vials over the course of a day and shipped them off to a lab in Colorado.

results, delivered on five faxed pages, revealed that his adrenal cortex was, as he put it, "fried." His level of cortisol, a hormone that helps to regulate the immune system and blood pressure and is affected by stress, was abnormally low in the morning and at noon, and higher than it should be at night. Those figures, according to the lab report, helped to explain his fatigue during the day and his inability to sleep at night.

Birdzell, then studying at the University of Virginia, took his results to a VA medical center in Alexandria and asked for more tests. He said a doctor there told him that the VA would measure cortisol levels only in the morning, not throughout the day, as he wanted. Once again, the department told him to see a psychologist for his PTSD.

Birdzell, 34, hadn't studied biology since high school, but a few days of research on the Internet had convinced him that his cortisol levels were at least partly to blame for the symptoms the VA was calling PTSD. "It's all biochemical - a lot of our psychology is a function of our biochemistry," he said. "If we nuke our biochemistry at war, how can our psychology be correct?"

Birdzell thought about taking drugs to regulate his cortisol output but decided instead to try to stimulate his adrenal cortex.

What he required was to relax, to find internal peace after eight years of war. "I'd been running on adrenaline," he said. "I needed to rest hard."

That's how Birdzell, a show-no-weakness Marine who now works as a fundraiser for the National Vietnam Veterans Association, found himself on his back, shirt open, shoes off, as Duggan, an acupuncturist who specializes in holistic health, beseeched him to spend 15 minutes meditating with pins in his back and chest. Duggan could tell Birdzell was keyed up, even if he didn't know that his patient had sped there along the Capital Beltway, peeled into the parking lot of a nondescript office park, and charged up the steps, that 15 minutes ago in the car, he had expressed regret for not killing more insurgents in Iraq.

r a quarter-hour, Duggan returned to the room, removed the pins and inserted clean ones in Birdzell's back, which had been aching since his last appointment, a pain he chalks up to his military service.

More pins pierced the skin, Duggan asked Birdzell for a progress report on his attempts to cope, to deal with his flashes of anger and his insomnia, to ease the pressure in his back and the tension in his knees.

Transcendental meditation, he answered, for 20 minutes a day, at his desk at the NRA.

"I can't find relaxation there," he said.

Duggan took Birdzell's pulse at four points on his wrists, the former Marine told the acupuncturist about his latest hormone tests. His cortisol levels are closer to where they should be, leading the VA to remove PTSD from his list of ailments, but four other hormones analyzed at the Colorado lab, including his testosterone production, registered far lower than normal.

"It's my hardware, not my software," he told Duggan, who nodded in agreement.

Instead of medicating himself, Birdzell wants to try to relax his way to hormonal equilibrium. He believes in the concept of "neuroplasticity" and "brain regeneration" - of trying to teach his brain to heal.

"I hope you show the way to other veterans," Duggan said.

"That's the plan," Birdzell replied.

Duggan buttoned his shirt, fastened his belt, laced up his black oxfords and headed to his car. The zen of his hour-long appointment remained with him down Interstate 95 and along the Beltway. When he hit rush-hour traffic in Tysons Corner on his way home. A ribbon of brake lights lined up along the side of the 123.

Duggan clenched the steering wheel and uttered an expletive. Then he caught himself.

"I'm calm," he said to himself. "I've got to stay calm."

Counting an injured brain

ing across from each other in the back of a laboratory at the VA medical center in Richmond, archer David Cifu asked Chase Villavicencio when he had toppled off the ladder.

villavicencio, a 28-year-old Marine corporal, hunched over and began to count the months on his fingers.

February, March, April," he whispered to himself as he pushed three fingers back.

May," he said. "It was May of 2011."

He raised his head with an apologetic gaze.

May," he said. "Sometimes I have to count the months."

The old Villavicencio never would have counted on his fingers. The old Villavicencio would have had the answer in an instant.

"Simple things take me a while now," he said. "I have to concentrate. It doesn't come naturally anymore."

He nodded understandingly. But he still needed details. The circumstances of Villavicencio's concussion were essential to determining whether he should be included in a first-of-a-kind study of the long-term effects of mild and moderate traumatic brain injury.

"Remember hitting the ground," Villavicencio said.

"Did I then?" Cifu asked. "Were you awake?"

"I don't really remember."

"How long from la-la land to getting on your feet?"

"About an hour."

Villavicencio initially brushed off the fall. Other Marines in the area had been shot. "My reaction was, 'I'm alive,' " he said. "I really didn't think much of it."

Then he started getting headaches. He couldn't stand bright sunlight. He developed a blurry spot in his right eye. He began to forget simple details. "All of a sudden, I sound like an idiot," he

but still didn't seek help.

In the Marine Corps, there's a mentality: There's a job to do," he said. "As long as you can keep going, you keep moving."

Last fall, however, after his forgetfulness became apparent at work - "I was making calls to the wrong person twice to set up appointments" - his superiors realized that he needed to get help. They sent him to the Richmond VA, which has an inpatient program that provides rehabilitation services for those with brain injury.

When the veteran completed his story, Cifu switched into sales mode. Villavicencio, who is in the process of receiving a medical retirement from the Marine Corps, appeared to be an ideal candidate for the study, which will track 2,000 veterans for two decades or more.

"I'd love to get you enrolled in this program," Cifu said. He explained that participants would receive an annual brain MRI, extensive blood tests and other assessments to monitor their recovery.

"What you had was a concussion - no doubt about it," he said. "We're trying to better understand what happens to people who have concussions while at war."

Villavicencio looked intrigued. He brought with him a copy of his favorite book, Cormac McCarthy's "The Road." He used to zip through it. Now he finds himself reading lines over and over, struggling to grasp the meaning.

He wonders if, one day, the words will become clearer. So does Cifu.

"I'd like to follow you for the rest of your life," the doctor said.

ping with burned-out lungs

alf past 10 in the morning in Las Vegas, after waking from a fitful sleep, after a VA-funded health aide has helped him out of bed and into a seated shower, after he has painstakingly pulled on a shirt and shorts, after brushing his shoulder-length gray hair and scruffy beard, Daniel Meyer guided his wheelchair to the carpeted landing in front of his bedroom door for the most complicated prosaic task of his day: heading downstairs.

He slid onto a chairlift affixed to the banister. And then he pulled off a tube, connected to an oxygen-whirring machine upstairs, that feeds oxygen into his nostrils.

Quickly, before running out of air, he reached for another oxygen tube, this one connected to a machine downstairs, and affixed it over his ears and under his nose. Then he began to glide to ground floor, coiling the tube to keep it from getting kinked in the lift.

After he went downstairs, he pulled himself into an electric wheelchair, motored to the living room, and bedded onto a beige reclining sofa and leaned back. His bearded face flushed, he emitted a low groan. "Just getting out of bed and coming down here - it's enough to tire me out," he said.

Before Iraq, the 29-year-old Meyer would have bounded down the stairs and out the door for a half-mile run. Whippet thin, he worked with an elite rescue unit stationed at nearby Nellis Air Force Base, repairing electronic equipment on HH-60 Pave Hawk helicopters designed to fly behind enemy lines and pick up downed airmen. It was a job that required him to be in top physical condition.

In 2007, he was sent to Balad Air Base, a vast encampment north of Baghdad that housed thousands of U.S. troops and contractors. Food and water were trucked in, as were all sorts of luxuries - bags of chips, tins of chewing tobacco, cans of near-beer - sold in a giant PX. But none of the trash was trucked out. Instead, all of the plastic bags and cans, and everything else considered garbage, were hauled to a giant pit, slathered with JP-8 jet fuel and set alight. A plume of thick black smoke often wafted over the base.

Weeks after his unit arrived for a mission to conduct medical evacuations of wounded troops, commanders on the base grew alarmed that birds attracted by the piles of trash were striking

flying aircraft. The concern filtered down the chain of command to Meyer, the most junior man in his unit, who was ordered to report to the base maintenance office. He was handed a M16 gun - but no mask, goggles or respirator - and told to enter the smoky burn pit. His mission was to shoot as many birds as he could, for as long as he could.

It felt like hell to him. Half the pit was on fire. The other half, where he lurked for birds, was awash with the detritus of war: medical waste from the base hospital, bloody uniforms, tires, crates that once carried boxes of ammunition.

Meyer tried to cover his face with one hand as he aimed the gun with the other. "It didn't help," he admitted. "There was nothing I could do to keep from breathing the smoke."

When he got out 90 minutes later, his nose was bloody. He had a hacking cough. His phlegm had turned black.

Week later, he was ordered back in. And so it went, a dozen more times. "I was the low guy on the totem pole," he said.

Meyer picked it up and dealt with it."

On his next deployment, to southwestern Afghanistan, his unit was assigned to live next to a large burn pit on a NATO base. Soot was everywhere. "It would snow on us, for hours, days at a time," Meyer said.

When Meyer returned to Nevada, he began to cough up blood. It would take two years of medical tests, of struggling with military physicians for referrals to civilian experts, of skepticism and outright retribution from his superiors, who thought he was slacking off work, before he received a conclusive diagnosis of bronchiolitis obliterans. His bronchial tubes are scarred and narrowed, making it progressively more difficult for his lungs to absorb oxygen.

For Meyer and the non-military medical specialists who tested him, the cause is unambiguous: exposure to burn pits. The doctors also believe the burn-pit exposure is responsible for a buildup of fat in his knees that makes it impossible for him to walk or stand upright.

Obviously, you take risks when you join the military, but you never think your own country

ld poison you," he said.

ough Meyer owns a portable oxygen tank and a van with a wheelchair ramp, he spends most every day at home, on the beige sofa, under a sign that reads, "Live Well, Laugh Often, Love Much." He watches television, plays video games and talks to his wife, Harmonie, whom he met through Match.com shortly before his Afghanistan deployment.

His doctor doesn't want him to go out in the winter, lest he get sick. Summertime is out because the humidity of his medications makes him sensitive to sunlight. "I'm pretty much stuck here all of the time," he said.

Harmonie and Harmonie had wanted to raise four children. But they've given up on that. He's too sick to help with kids, and she wants to focus on him. She quit her job at a law firm to fix his meals, take him to medical appointments and to keep him amused.

"I'm not going anywhere," she said.

"I can't go anywhere," he replied with a laugh.

"People think we lead this big, tragic life," she said. "It's sad, but we still have a good time."

Every few hours, he pulled himself back into his wheelchair and motored to the bathroom. Each time, he appeared winded when he returned to the sofa. "The simple act of going to the bathroom room wears me out," he said.

Physicians have told him that his lungs are steadily failing and that he probably will need a double-lung transplant in five to eight years. Until then, he will have to remain connected to the ventilator oxygen tube.

"I'm not angry about it," he said. "I'd do it all over again. We saved more lives in Iraq and Afghanistan than my own life is worth."

Instead of wallowing in hostility or pity, he has set his sights on trying to raise money to install a simulator in his house - he wants to teach other wheelchair-bound veterans how to swing a golf club - and he's trying to reach out to other veterans who have been sickened by burn pits. He

ts them to seek out specialized medical care and apply for a full raft of benefits from the VA.

own ailments have led to the VA's second-highest disability rating, which entitles him to a time of monthly payments that cover all of his expenses. Harmonie receives additional pension for serving as his caregiver.

» American people are going to have to pay our disability and medical costs for decades," he as he prepared for the return trip up the stairs to go to bed. "It's not my fault. I did what I asked to do. But the costs will be staggering."