

There's a Suicide Epidemic in Utah — And One Neuroscientist Thinks He Knows Why

By [Theresa Fisher](#) November 18, 2014

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Living in Utah means packed powder in April, canyoneering in the clouds, snow-capped vistas so vivid they look Photoshopped — and the shortest average work week in the country. So it's not surprising that [surveys](#) show how much Utah residents [love](#) their outdoorsy, adventure-filled state.

But there's another side to Utah that isn't shown in surveys. Despite ranking as America's [happiest state](#), Utah has disproportionately high rates of [suicide](#) and [associated mood disorders](#) compared to the rest of the country. In fact, it's the No. 1 state for antidepressant use. These polarized feelings of despondency and delight underlie a confusing phenomenon that Perry Renshaw, a neuroscientist at the University of Utah investigating the strange juxtaposition, calls the "Utah paradox."

Utah residents and experts are aware of the paradox, often attributing gun use, low population density and the area's heavy [Mormon influence](#) as potential factors. But Renshaw thinks he's identified a more likely cause for the Utah blues: altitude.

Renshaw believes that altitude has an impact on our brain chemistry, specifically that it changes the levels of serotonin and dopamine, two key chemicals in the brain that help regulate our feelings of happiness. America's favorite antidepressants (and party drugs) work by controlling the level of these chemicals in the brain. The air in Utah, one could say, works just like this.

Since moving to Utah in 2008, Renshaw has found mounting statistical, scientific and anecdotal support for his theory. If Renshaw's theory holds true, his work represents a major step forward in solving a long-standing mental health mystery.

Westward, ho?

Utah lies in a region of the country commonly known as the Rockies, the mountain states or even just "out west." To those who analyze violent death data, it's known as the "[suicide belt](#)."

According to the National Violent Death Reporting System, a surveillance system run by the Centers for Disease Control and Prevention, Utah and other states in the Rockies consistently have the highest suicide rates in the country, aside from Alaska. In the map below, the block of red — states with suicide rates over 14 per 100,000 people — is hard to miss.

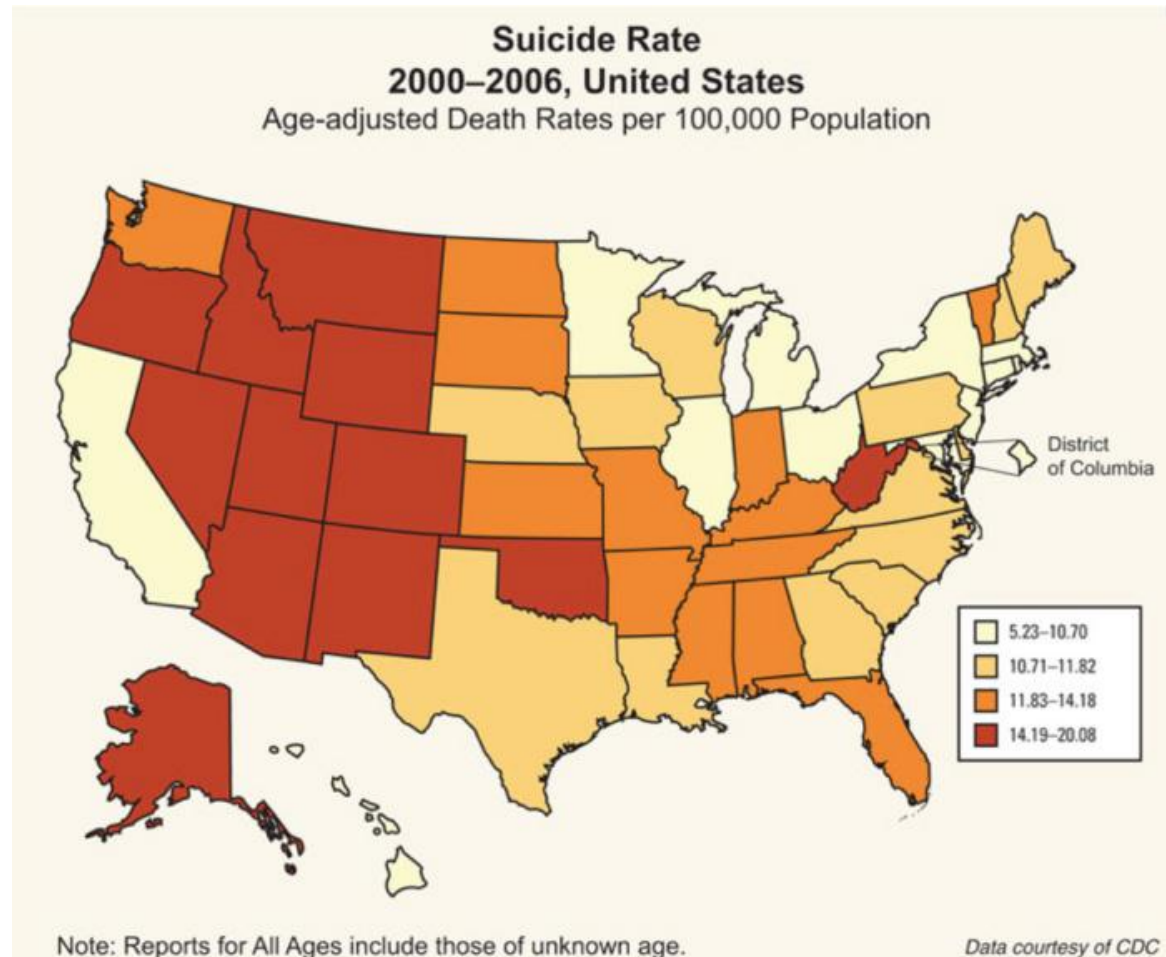


Image Credit: KSL.com via CDC

Before heading west, Renshaw studied the effects of drug abuse on brain chemistry at Harvard Medical School. When he started working at the Salt Lake City Veteran Affairs' mental illness center five years ago, suicide research was a priority. Shortly after Renshaw arrived, a suicidologist presented a map depicting suicide rates.

"From the beginning," Renshaw said, recalling his developing eureka moment, "the statistical evidence seemed off the charts."

To see if statistics could help explain why so many mountain-dwelling Americans commit suicide, Renshaw analyzed data on altitude, suicide and mental illness over the last five years.

In a [2011 study](#) published in the American Journal of Psychiatry, a group of researchers, including Renshaw, analyzed state suicide rates with respect to gun ownership, population density, poverty, health insurance quality and availability of psychiatric care. Of all the factors, altitude had the strongest link to suicide — even the group of states with the least available psychiatric care had fewer suicides than the highest-altitude states, where psychiatric care was easier to find.

In a follow-up study, Renshaw looked at instances of suicide that involved guns and those that didn't. Again, he found a positive correlation between suicide and altitude across the board.

Renshaw also used CDC violent death data to examine the relationship between altitude and mental illness. The elevation at which people live, he found, is a strong predictor of their mental health status.

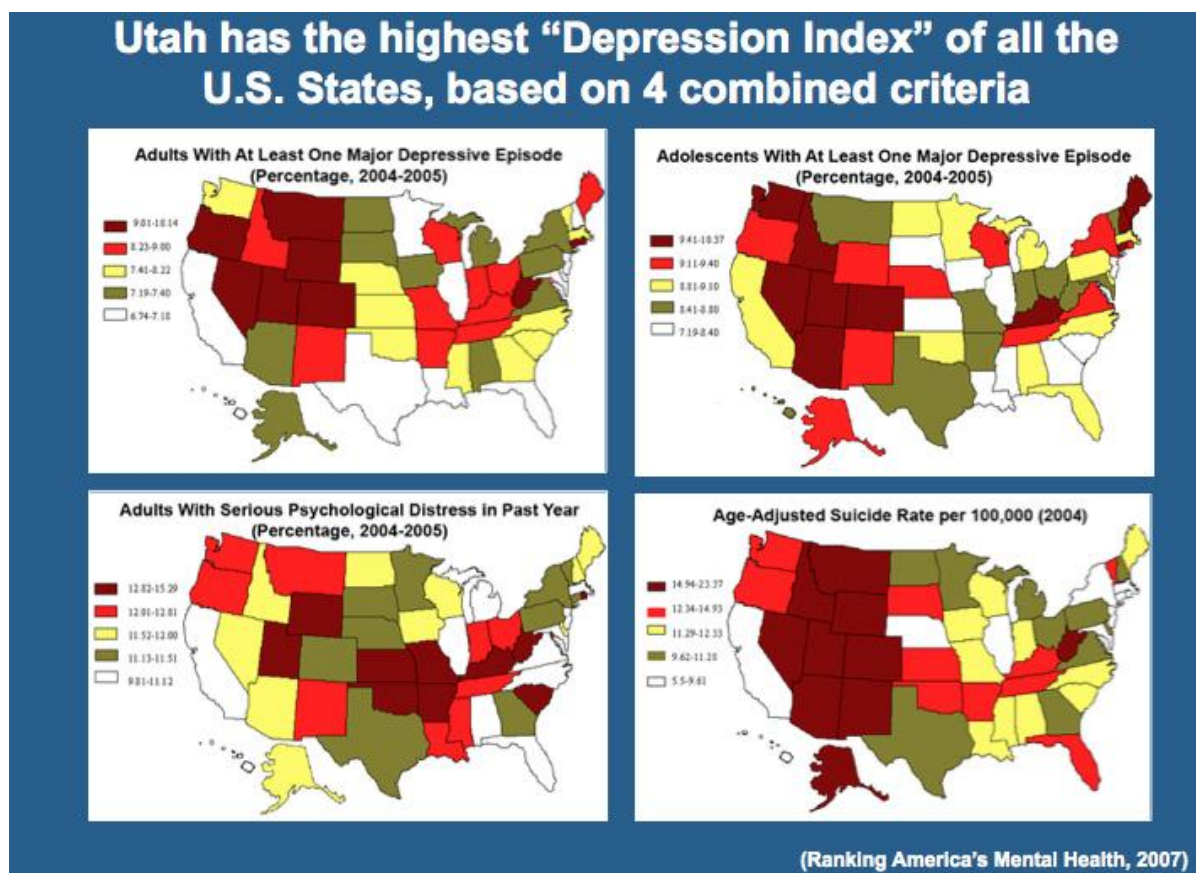


Image Credit: Perry Renshaw via Ranking America's Mental Health

Renshaw discovered research supporting his theory. Doctors from Case Western University, it turned out, were crunching numbers based on a similar hunch about altitude and suicide. In a [2010 study](#) published in High Altitude Medicine and Biology, the Case Western group analyzed suicide rates across 2,584 counties in 16 states and found that suicides start increasing between 2,000 and 3,000 feet in all U.S. regions. The U.S. isn't a special case — analysis of suicide rates in other countries, including South Korea and Austria, bore similar results.

Psychology research has also made a connection between mental health and elevation. In a [2005 study](#), the Naval Health Research Center measured mood changes in Marines who left seaside San Diego for 30 days of strenuous training in the Northern California mountains. Before training, the Marines completed a self-evaluation of their levels of anxiety, dejection, fatigue and bewilderment, among other mood symptoms. They completed the same evaluation after training ended, and then again 90 days later. While their physical fitness improved during training, their mental health disintegrated. Before training, the Marines reported more balanced mood levels than average college-aged men. By the time they finished, they described mood symptoms comparable to those of psychiatric patients. Ninety days later, they were just as sad and agitated.

All of this evidence, Renshaw says, seemed too strong to dismiss as coincidental. Based on a comparison of suicide rates at sea level and at areas above 2,000 feet, living at a high altitude may make people 30% more likely to commit suicide.

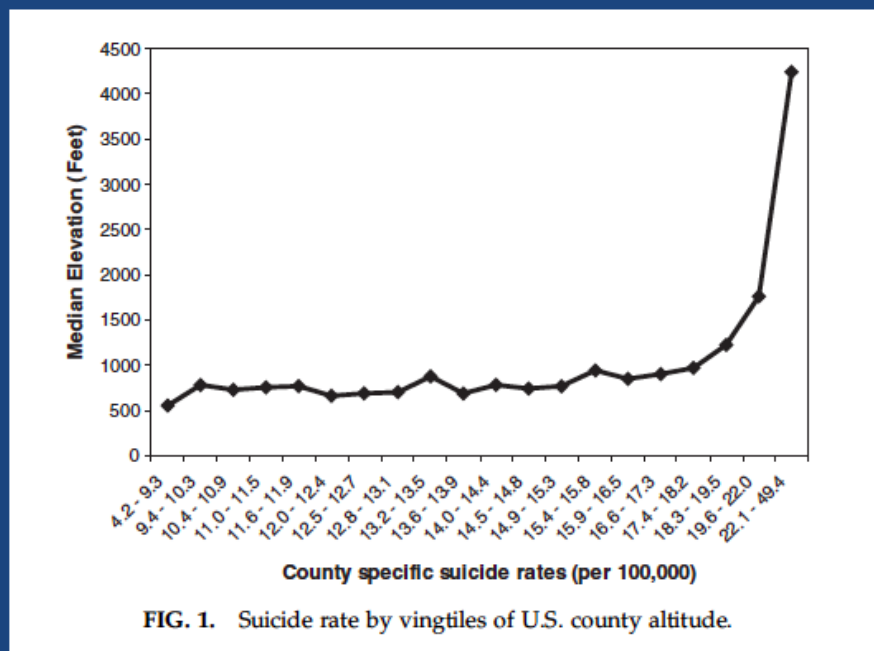


FIG. 1. Suicide rate by vingtiles of U.S. county altitude.

Brenner B, Cheng D, Clark S, Camargo, CA. Positive association between altitude and suicide in 2584 U.S. counties. High Alt Med Biol. 2011; 12(1):31-5.

Image Credit: Perry Renshaw via Journal of High Altitude Medicine and Biology

More than numbers

In addition to the statistical evidence, Renshaw collected anecdotes that supported his developing theory.

Five years ago in Park City, Utah, Renshaw presented his theory and his research on suicide. Afterward, he was approached by a female audience member who was part of a support group of

women — women who began showing symptoms of anxiety and depression only after they moved to Utah. She was floored to hear Renshaw's theory, which made sense of her group's shared, confusing mental health issues.

And Renshaw also learned that the U.S. Air Force Academy in Colorado Springs, Colorado, which sits 7,000 feet above sea level, struggled to hold on to out-of-state professors, who often left after a few months because they felt off, physically and mentally. Out-of-state students from low-altitude areas also fared worse academically than their in-state counterparts.

Renshaw himself undertook an informal study of researchers who moved to Utah from coastal areas and found that around 35% experienced new, often pronounced, symptoms of anxiety and depression.

Still, a host of evidence spoke to the other side of the paradox — the positive feelings associated with living in America's "happiest" state. Clinical trial participants who grew up in Utah and moved away, for example, often told Renshaw they returned home to the "call of the mountains." He spoke to researchers in Colorado who reported the same trend: People born and raised in the mountains moved to lower land and found themselves longing for their home state.



Salt Lake Valley. Image Credit: Scott Catron via Wikimedia Commons

Additionally, Renshaw became aware of a Latter Day Saints training center in Provo, Utah, where Mormons from around the country went to brush up on religious recruitment skills. He heard that many missionaries in training diagnosed with ADD stopped taking their medication within a few weeks of arriving at the center. This medical quirk dovetailed with statistics about ADD and ADHD — the rate of diagnosis in Salt Lake City is consistently 50% lower than ocean-hugging New York City.

Together, the stray statistics and stories about life out west tipped off Renshaw to a common culprit: altitude-induced oxygen depletion.

There is such a thing as too much fresh air

As anyone who saw *Gravity* knows, oxygen density decreases as altitude rises.

Oxygen deprivation from high altitude induces a condition called hypobaric [hypoxia](#), which ranges in severity based on how little oxygen is available. Some hypoxic effects are well known — nausea and headaches from altitude sickness, nosebleeds and lower alcohol tolerance, for example. But while physical afflictions associated with hypoxia have gained academic and [mainstream attention](#), scientists have largely ignored its potential impact on mental health.

Renshaw believes that oxygen-poor air tampers with brain chemistry, leading to a drop in serotonin and an uptick in dopamine. Serotonin and dopamine are neurotransmitters, brain chemicals that relay signals between neurons and other cells.

Serotonin, an inhibitory neurotransmitter, helps stabilize emotions. Antidepressants — SSRIs, (selective serotonin reuptake inhibitor), which include Prozac and Lexapro — work by blocking the transport of serotonin back to the neurons, thereby increasing its supply in the brain.

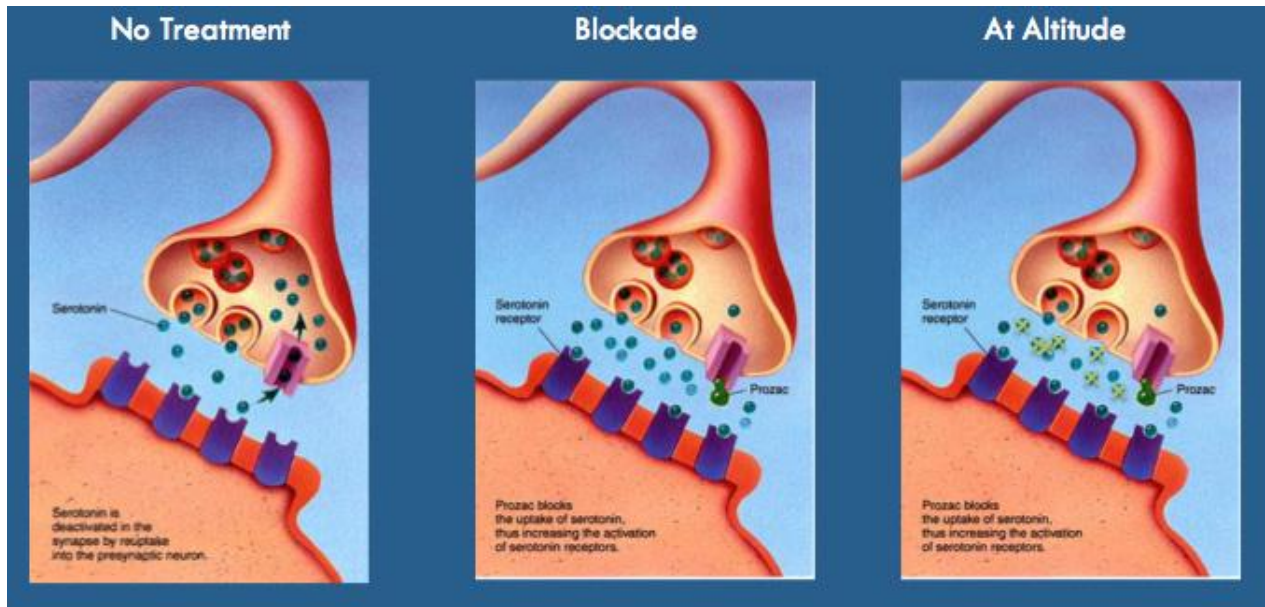
Dopamine, an excitatory neurotransmitter, plays a vital role in our ability to focus. Too little dopamine can make us scatterbrained, whereas a dopamine increase causes hyper-concentration and feelings of euphoria. Caffeine, prescription drugs, including some ADD/ADHD medications, and illegal stimulants like cocaine and methamphetamine, work by increasing the availability of dopamine in our brains.

So why do some people enjoy the benefits of the Utah air's impact on increased dopamine levels, which should make us happier, and some fall victim to the impact on decreased levels of serotonin, which would make us more depressed?

The answer lies in how changes in neurotransmitter levels affect our individual brain chemistry.

As Renshaw's theory goes, serotonin deficiency exacerbates symptoms of pre-existing anxiety and depression, increasing the likelihood of becoming suicidal (mental illness is a factor in about [90%](#) of suicides). People with an existing mood disorder, or a predisposition to mental illness, would be more sensitive to the effects of waning serotonin levels.

Women, who naturally have half as much serotonin as men, Renshaw said, are more likely to develop a mood disorder as a result of living in the mountains (about 24% of middle-aged women in Utah take an SSRI — double the national rate. The various anecdotes about anxious Utah women, Renshaw believes, bolster his theory).



From left to right, depiction of serotonin release in a control situation, affected by SSRI Prozac, and at a high altitude. Image Credit: Perry Renshaw

But those without a predisposition to mental illness will, on the flip side, feel happier. By Renshaw's estimates, the brain makes about 20% more dopamine in the mountains.

People who leave their hearts in Utah might be homesick for their family and friends, but they may also be missing the high of living up high. Outdoor junkies, Renshaw proffered, could be just that: junkies jonesing for some oxygen-deprived air.

Similarly, though Mormon missionaries attribute discontinuing ADD medications to a religious awakening, Renshaw proposes a more cynical explanation: Since ADD and ADHD are both dopamine deficiency disorders, these missionaries are trading one source of dopamine enhancement for another.

Utah pharmacies are dispensing SSRIs in droves, especially to middle-aged women. But Renshaw isn't sure the pills are working. SSRIs don't create serotonin — they merely preserve what's already in the brain, thereby increasing the availability of a chemical that helps balance mood. Thanks to the blood-brain barrier, it's notoriously hard to treat neurologically-based disorders through traditional treatment methods, like pills, injections or adhesive patches. We can get medication into the bloodstream, but it won't actually reach the brain. For people who don't have any serotonin — perhaps because hypoxia decreased their already-low supply — SSRIs are probably no more effective than prescription-plan tic tacs.



Squaw Peak in Provo, Utah. [Image Credit](#): Pastelitodepapa via Wikimedia Commons

A controversial theory

Renshaw's previous neuroimaging work at Harvard laid the foundation for his theory that oxygen deprivation affects brain chemistry. Using the same equipment that generate MRIs, magnetic resonance spectroscopy (MRS) lets scientists measure minute levels of neurotransmitters in the brain. Before shifting his focus to the altitude-addled brain, Renshaw used MRS to study the impact of drug abuse on brain chemistry.

"If I wasn't a spectroscopist and studying changes in brain chemistry associated with mood disorders," Renshaw said, "there's no way I would have figured out the connection between altitude and suicide."

Others didn't see it like he did. When Renshaw peddled his altitude-suicide theory around the mountain states in 2008, he faced prickly reception. Renshaw heard that Utah's governor at the time, Jon Huntsman, was disgusted that the state would fund the anti-Utah research. Huntsman's staff did not respond to a request for comment.

And Renshaw said he delivered a presentation at Mormon-stronghold Brigham Young University that provoked outrage among audience members. However, after he finished

speaking, three students shared separate stories of friends or relatives committing suicide shortly after moving to Utah.

But Renshaw insists that mountain folk need not flee to the coasts based on his findings. Rather, understanding how altitude might affect brain chemistry is knowledge that can be used to improve mental illness treatment and, hopefully, curb suicide.

More and more, scientists are starting to see it how Renshaw does.

Doug Gray, a suicidologist at the University of Utah, has been studying suicide in the western mountain states for over 20 years. Whenever he makes a presentation, Gray said, he asks audience members why they think the region has such high suicide rates. People generally offer a cultural explanation, but Gray's never been persuaded.

"Nevada and Colorado also have high suicide rates," Gray said, reflecting on theories ventured over the years. "You tell me how Salt Lake City and Las Vegas have the same culture."

About six years ago, Renshaw caught Gray's presentation at a conference where Renshaw was also scheduled to speak. Gray posed his usual question to the audience and, per Gray's recollection, Renshaw raised his hand and said, "Did you know that at high altitude, the brain goes through metabolic changes, and some people can adapt while others can't, based on their DNA?"

Gray's jaw dropped.

"Well," Gray recalls saying, "that would explain it."

Renshaw's work, in Gray's opinion, won't gain mainstream acceptance for a while. But, he believes the theory is only getting stronger, as Renshaw corroborates the mental illness-altitude connection through animal studies and clinical trials for natural substances to help treat some hypoxia-induced mood disorders.

Renshaw, too, is confident his findings are beyond the realm of a fluke, but he isn't willing to dismiss other explanations for the suicide-altitude connection, including studies on gun access. Multiple overlapping factors, he says, are likely in play.

Nevertheless, some environmental factors we commonly accept as relevant to our mental welfare seemed absurd less than a generation ago. In the 1980s, for example, experts were skeptical that depression could stem from seasonal shifts in sunlight exposure. But 30 years after seasonal affective disorder got its name, SAD sufferers plant themselves in front of light boxes to combat the winter doldrums without anyone raising any eyebrows.

As a practical matter, Renshaw said, it's hard to study the impact of changing altitude on neurotransmitter levels in humans. But [studies](#) have looked at brain chemistry changes in rats at very high simulated altitudes — comparable to that of the Andes mountains — and seen

serotonin levels drop while dopamine levels surged. Renshaw is currently conducting his own study on neurotransmitter levels in rats at different altitudes.

When it comes to subjects as biologically and environmentally thorny as mental health and suicide, Renshaw said, the answer is always more research.