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Health

# The Chilling Mystery of High-Altitude Suicides

U.S. counties above 4,000 feet have twice the suicides as counties at 2,000 feet. Is it because there's less oxygen in the air, or is something else going on?

By Shayla Love

June 25, 2019, 5:00am



**E**very night, Audrey Hart breathes in a flow of 50 percent oxygen at two liters a minute from a tube connected to a white machine the size of a toaster oven. She keeps it in her bedroom to use while she falls asleep. She bought the machine on Amazon for around \$500 in August of 2017, a month after she came the closest she ever had to killing herself. “You get to that low where it's just so consuming that you honestly feel like the world is

because no one wants you here.

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In addition to now taking medication for depression, Hart supplements with oxygen—an idea that came from published studies out of the University of Utah, close to her home near Salt Lake City. Researchers there are trying to explain a long-observed phenomenon: that suicide rates are much higher in certain parts of the western United States. Of the 10 states with the highest suicide rates, eight are in a region darkly deemed “the suicide belt.” In the [heat map](#) of suicide deaths from the CDC, the suicide belt cuts across the country in dark red—including Colorado, Montana, Utah, Idaho, and Wyoming.

One thing that these states have in common is high elevations. In 2011, a handful of scientists from Utah put forth a provocative theory: that the high altitudes are contributing to the high suicide rates. They said that a lack of oxygen can lead to hypoxia, or oxygen deprivation, and affect fundamental processes of the brain, like the production of the neurotransmitter serotonin, which is thought to play a key role in mood. They think it could also potentially affect the functioning of depression medications like SSRIs.

explanation, and ignores the overwhelming sociocultural attributes of these areas—access to guns, poverty, social isolation, a dearth of mental health services. In Utah, the Mormon Church can also be a suffocating presence that has a heavy impact on LGBTQ youth. The skeptics worry that an over-focus on the fringe physiological influence of altitude could distract from getting people the help they need, and put the focus instead on oxygen machines and supplements.

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One night in July of 2017, when she was ready to end her life, Hart's two daughters, 7 and 8, ran up and hugged her. She said their embrace is what saved her. Shortly after, her husband Ryan read one of the studies coming out of the university, and pushed for her to start getting more oxygen. He said to her: "I think there's a serious correlation here. I think it's worth buying an oxygen machine for you."

**I**n 2017, suicide was the leading cause of death for people in Utah ages 10 to 24, and it was the second leading cause of death for people 25 to 44. The rate of teen suicide in Utah is more than double the national rate, and its youth suicide rate has tripled over the past 10 years. More young people die of suicide in Utah than from car accidents.

Boston, where he had worked at Harvard University studying the differences in brain chemistry of depressed people. When he arrived, the suicide rates in his new home made him wonder: Was there something about the elevation that was affecting the way the brain functioned?

His theory didn't catch on until he and his colleagues published a [2011 paper](#) that looked at all 2,584 counties in the U.S. and found a correlation between average altitude and suicide rate over the previous 20 years. They found that if a county was below 2,000 feet, their suicide rates were about half of counties at 4,000 to 5,000 feet. The counties with the highest suicide rates were above 9,000 feet.

"We got taken much more seriously at that point in time and we were off to the races," Renshaw said.

A subsequent [study](#) attempted to control for the other factors commonly thought to influence suicide rates, like gun ownership, poverty, availability of psychiatric care, population density, and health insurance status. Renshaw said they still found that altitude was an independent risk factor, calling the correlation

"whoppingly strong." Since then, there have been multiple studies that showed the same association, both on [state](#) and [county](#) levels. Similar findings have been reported in [Spain](#), [South Korea](#), and [Austria](#).

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Their hypothesis began to trickle into the mainstream after the 2011 paper. When the Utah Foundation, an independent research group, released a report in 2018 on the “startling” rise in suicides, it included a mention of Renshaw's findings—that the counties with the highest rates are ones with higher elevations. The Montana Department of Public Health began to note the altitude of each suicide in their state, California Sunday reported, and found that suicides took place at an average elevation of 3,508 feet. Around half of people who died by suicide had moved to Montana from other states, making space for a theory that a shift from low to high elevations was a risk factor.

After observing the connection, Renshaw and his colleague, neuroscientist Shami Kanekar, brought their hypotheses to the lab. Kanekar put rats in altitude chambers that simulate different elevations, like sea level, 4,500 feet and 10,000 feet.

She said that in the rats housed above sea level, they saw depression-like behavior in the female rats—what scientists use as proxies for depression in animal models. This includes a “forced swim test” which observes how long it takes rodents to give up treading water. In a follow-up study from 2018, also in rats, Kanekar found that Prozac, Paxil, and Lexapro all lost efficacy at altitude, though Zoloft did not.

Their working theory is that the lack of oxygen in the air disrupts the production of serotonin in the brain. Oxygen is required in a process that converts an amino acid called tryptophan to serotonin. Renshaw theorized

tryptophan, or 5HTP, which eventually becomes serotonin.

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Renshaw's research has recently moved from animals to humans, to see if intervening in the serotonin production process can help. The first study was an open-label pilot study in 2017, on women in Salt Lake City who had been depressed for an average of six years without improvement, despite taking an antidepressant. They gave the women 5HTP and creatine, another amino acid that interacts with the brain, and found that within six weeks, the women's depression had significantly improved.

But in any research, it's important to have a study design that does its best to prevent placebo and bias. Now, Brent Kious, a psychiatrist at the University of Utah who led the pilot study, is conducting a double-blind trial with 5 HTP and creatine, with a larger sample of women to see if they can replicate the findings.

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Kious was also the first author on a study from May that looked at medical interns who moved from low altitude to high ones. They found that the interns who moved from sea level to elevations like the University of Utah were more likely to get depressed, admittedly only a little bit, he said. The subjects gained a couple of points on a self-reported depression measurement scale called the PHQ-9 score. If you're not depressed already, it wouldn't be that big of a deal, he said, but if someone is moderately depressed, "maybe that does make a difference, and that impacts the risk that you're going to commit suicide."

All of the researchers' work consistently provokes intense reactions from the public. When Renshaw presented his research at BYU, he said that Mormon women crowded to ask him if they should buy plants for their daughters, to give them more oxygen. A man who traveled a lot for business told them that when he came to the area, he could feel his antidepressant wearing off. People shared anecdotes of lives lost to suicide in their families, sometimes occurring shortly after moves to higher elevation.

"People have emailed and said, 'Thank god these papers came out,' Kanekar said. 'I finally understand what's going on with me.'"

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Experts who feel concerned that an over-emphasis on altitude distracts from the more influential factors that lead to suicide.

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Ben Honigman is a Professor of Emergency Medicine at the University of Colorado School of Medicine, where he's been studying the effect of altitude on health since the late 1980s. He's looked at cardiovascular disease and pulmonary effects at high elevations, and began to investigate suicide when he saw Renshaw's paper first come out. He's not convinced by their findings.

He said that the research that's been done so far is based on observational data, which can't provide causality—or hard proof that altitude *causes* depression. He has concerns about the way the studies were designed, too. The way different researchers measure altitude varies—some use the mean altitude of the state capitals, while some use counties, which are large areas where altitude can vary. Many of the studies use aggregated suicide data, and should instead strive for individual characteristics of each person who died by suicide. Only one did so in a [recent review](#) Honigman published.

“We cannot simply generalize association between altitude and mental health,” said Hoehun Ha, an assistant professor of geography at Auburn



and altitude in his research. My previous research provides important information showing that the issues of depression and suicide and psychiatric issues at altitude are very complex...These factors are likely more plausible than hypoxia to explain depression and suicide.”

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Honigman said that for his and others’ work in hypoxia, altitude does affect the body, there’s no controversy there. But many of the physical changes that come with high elevation take place at much higher elevations than 3,000 to 4,000 feet, usually around 8,000 to 10,000 feet.

“We have found many other factors that are probably at play with altitude; if it has any role it's minor,” Honigman said.

**T**here is a tangled web of social factors that can lead suicide to be more prevalent in certain areas, said Seth Abrutyn, a sociologist at the University of British Columbia. He and Anna Mueller, a sociologist at The University of Chicago, study adolescent suicide and suicide contagion, or when suicides increase in one location. In April of 2019, the Wall Street Journal [reported](#) on one such occurrence in Utah: a town where six students from the same high school died by suicide in less than a year.

vulnerable. Having strong support networks is key for lowering a community's suicide rate, as is a "strong sense of moral clarity" among the members of a group, Abrutyn said.

"Teenagers are the perfect example of this, where they're stuck between the adolescent peer world, and the family world that they're sort of leaving," Abrutyn said. "And the norms, or the values, that these two worlds have are often in conflict, and that can create a sort of confusion as what to do."

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Both of these kinds of support have eroded in rural small towns that often make up the suicide belt. "People have left because the manufacturing industry collapsed over the last 30 years," Abrutyn said. "There's no jobs. There's no way to support a middle-class life. And so these towns have been in flux." Additionally, since the 1980s, the federal government has been cutting nation-wide programs that provide social safety nets, including mental health programs.

What Abrutyn and Mueller have found in terms of clustering of teen suicides is that once a suicide takes place, a kind of "suicide script" is introduced, and the people that face these pre-existing various issues consider suicide to be

“Anna and I have come to think that the communities where this happens are just the unlucky ones,” Abrutyn said. “We don't think it would take much to light the fire in many of these communities. That is, one adolescent completing suicide could theoretically start what's sort of the underlying problem in most places.”

Abrutyn said we should feel skeptical when a purely environmental theory is proposed regarding suicide.

“It's really complicated whether or not mental illness is truly only organic and biological,” he said. And since he worries about suicide becoming normalized, or part of a community's narrative, telling people that they live in a place prone to suicide could potentially exacerbate the problem.

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"It can become: 'Well, you know people here die because we live at high altitude, so it's common,'" said Abrutyn. He thinks that even if altitude is a minor factor, addressing it won't get at the larger issues—which could help restore the missing sense of community. Giving people an oxygen machine

adequate mental health resources does, he said.

For example, in May 2019, Renshaw and his colleagues looked at the relationship between military veterans and altitude and found that there was a significant correlation between a state's mean altitude and the total veteran suicide rate. Honigman and Abrutyn, meanwhile, said they didn't want an over-focus on altitude to get in the way of all of the other issues that face veterans.

"You could be ignoring all the other PTSD, and trigger effects, and everything we know about combat issues, and access to weapons, and all these other things that really go into, and are scary, that go into suicidality," Honigman. "And that's the real problem."

**R**enshaw and his colleagues are open to the possibility that altitude might turn out not to be a very strong influence—but each study they complete convinces them further that altitude is worth paying attention to. "It has just replicated time and time again," Kiouss said. "I think it would be really surprising if it turned out not to be real."

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levels as more easily addressed. You're not going to change your culture," she said. "Or say, 'I'm poor, I'm going to become rich.' But biological risk factors are actually modifiable, right? You can, if you find the right treatment, you can find something to help these people."

Renshaw believes that there are likely people who are more vulnerable to the negative effects of altitude, namely the ones who have a pre-existing psychiatric condition. He also thinks moving to a high-altitude place for the first time, and being subjected to stress—like the students he sees everyday at The University of Utah—can increase a person's susceptibility.

Audrey Hart has lived in Utah all her life. She's had depression since high school, but it got worse when she was older, and there were two times as an adult that she had intense suicide ideation.

Hart said that a lot of people she knows have depression, including many of her family members: her grandparents, her mom, her cousins. In Utah, everyone knows of someone who died by suicide, she said. She would move out if she could—and she's tried. But it hasn't been easy to find a job somewhere else and uproot her whole life.

She doesn't think it is *just* the elevation that causes her depression, but she's convinced it's a factor. Marissa Roosendaal, 28, who grew up in Salt Lake City, feels the same. She already had depression and anxiety in college at the University of Utah, and it got worse when she moved up to Summit Park, which has an elevation of 7,000 feet, compared to Salt Lake City's 4,000.

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“Right after we moved up there, I got really depressed and really anxious really quickly, and it was pretty extreme,” Roosendaal said. “Like nothing compared to what I had experienced before.”

She also went from living with her family, planning a wedding, and being surrounded by friends to being isolated and working as a nanny. “I think that had an impact, but just how fast it came on and the way that I felt, it felt like there was more to it,” Roosendaal said. “It felt like I was living in this fog.” Now that she lives in Sandy, Utah, which is closer to Salt Lake City, her mood and health has improved.

If someone feels less depressed doing something that doesn’t hurt them—like using an oxygen machine or living at lower elevations—Honigman, one of the altitude skeptics, said that at the end of the day, he doesn’t need a firm explanation of why it helps them. “I would never say to anybody that their symptoms aren't real, but I don't have a physiologic explanation for them,” he said.

For that reason, despite his skepticism, he even thinks this research should continue. He just struggles with the strong claims that are being made and craves more nuance, and a more rigorous study design.

Ultimately that sets him apart from Renshaw, who said, “Every study that's been done that I'm aware of over the last five years finds the same

Ryan, Hart's husband, said that since she's been using the oxygen, she's better than ever before. "She's sociable, she's going out of her comfort zone, she's talking with people, she is active, doing a lot of things, good mood, happy," he said.

If she had to pick any single thing that benefits her depression, it'd probably be medication, Hart said. But she's going to keep using the oxygen machine. "Still, I think it helps. I think it does help. And even if it doesn't, you can't go wrong."

*If you or a loved one are in need of help, call the National Suicide Prevention Lifeline at 1-800-273-8255. In Canada, visit [suicideprevention.ca](https://suicideprevention.ca) for more information on how to get help.*

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