

# Understanding the Relationship Between Altitude and Suicide Risk



## From Science to Practice

Using Research to Promote Safety and Prevent Suicide

### Issue

People who live at higher altitudes are at increased risk for suicide — a phenomenon that has been documented both in the United States and in other countries.<sup>1,2,3,4,5,6,7</sup> One study found that the suicide rate in the United States begins to increase significantly at an altitude of 2,000 feet and continues to increase with higher altitude.<sup>2</sup> In the United States, the association between altitude and suicide appears to be stronger for Veterans over the age of 35 than for non-Veterans and Veterans ages 18–35.<sup>8</sup>

## Key Findings

### *Altitude, Suicide Risk, and Mental Health*

- Suicide rates in the United States are positively correlated with altitude at both the state and county levels. This remains true after accounting for other variables, such as gender, poverty, population density, and access to health care. The relationship has been reported both in the general population and more recently among Veterans over the age of 35.<sup>2,3,8</sup>
- When looking at average U.S. county-level elevation, suicide rates have a stronger positive relationship with altitude in parts of the northern Plains states (Minnesota, North Dakota, South Dakota) and the Southeast (West Virginia, Virginia, North Carolina, and parts of Louisiana), while there is a negative relationship between suicide rates and altitude in Indiana and Illinois.<sup>3</sup>
- While state-level firearm ownership rates are associated with rates of Veteran firearm suicide, mean state elevation is associated with both firearm and non-firearm suicides, among both Veterans and the general population.<sup>2,8</sup> This suggests that the relationship between altitude and suicide is not attributable to differences in state firearm ownership rates.<sup>2,9</sup>
- Living at higher altitudes is correlated with past-year serious psychological distress and with experiencing at least one major depressive episode in the past year.<sup>10</sup> Moreover, a study of physician interns found that relocation from a low-elevation region to a higher elevation was associated with increased symptoms of anxiety, depression, and suicidal ideation than relocation to another low-elevation region was.<sup>11</sup>

- People diagnosed with bipolar disorder who live at higher altitudes may be at greater risk for suicide than people diagnosed with other mental health disorders, such as anxiety disorders, major depressive disorder, or schizophrenia.<sup>12</sup>

### *The Role of Oxygen in Serotonin Signaling and Brain Energy Metabolism*

- The partial pressure of oxygen in the atmosphere decreases as altitude increases due to the corresponding reduction in barometric pressure. This can result in chronic hypobaric hypoxia, in which the partial pressure of oxygen in the bloodstream significantly decreases.<sup>13</sup> This is one possible explanation for the relationship between altitude and suicide.<sup>14</sup>
- Chronic hypoxic conditions, including living at a high altitude above sea level, may increase suicide risk in Veterans. Researchers studied three markers of hypoxia (smoking, altitude, and chronic obstructive pulmonary disease, or COPD) in relation to completed suicides. Veterans who had at least one of these conditions had significantly increased odds of suicide, and the odds of suicide among Veterans who had all three hypoxic conditions was nearly four times that of those without hypoxic conditions.<sup>15</sup> And notably, suicide risk among Veterans was shown to increase with each additional 1,000 meters above sea level.<sup>15</sup>
- Two mechanistic biological pathways have been identified as potential contributors to the relationship between altitude and suicide. A systematic review of studies found that simulated high altitude leads to a reduction in serotonin signaling,<sup>14</sup> a change associated with both major depressive disorder and suicidality.<sup>16</sup>

# Understanding Nonsuicidal Self-Injury and Suicide Risk Among Veterans

The second pathway involves impaired energy metabolism in the brain (i.e., mitochondrial dysfunction), which mirrors biomarkers associated with depression and suicidal behavior.<sup>17</sup>

## Implications

More research is required to understand the relationship between altitude and suicide. Although recent findings implicate chronic hypoxia as a contributing factor, it is possible that demographic, social, and environmental factors play an important role in the relationship between altitude and suicide. If a causal link between altitude and suicide risk emerged, it would have important consequences for prevention and treatment. For instance, evidence points to a hypoxic decrease in serotonin signaling as one of two mechanisms for increased suicide risk at higher altitudes. The decrease in serotonin may reduce the effectiveness of selective serotonin reuptake inhibitor (SSRI) antidepressant drugs.<sup>14</sup> This could have important implications for clinicians who treat the multitude of conditions for which SSRIs are prescribed. Finally, and most importantly, to better treat depression and prevent suicide at higher altitudes, future research should identify novel treatment targets and test the corresponding interventions.

## Ways You Can Help

- Be aware of the potential influence of altitude in contributing to suicide risk and its potential effect on symptoms of depression, anxiety, and psychological distress. This relationship appears to exist both for those already living at a high altitude and for those who relocate from a low to a high altitude.
- Consider the relationship between hypoxia-related markers other than altitude (e.g., smoking or COPD) and the risk for suicide. The finding that suicide risk increases with the number of hypoxic conditions suggests that patients with multiple conditions may be at especially high risk.
- Research shows that firearm ownership and firearm storage practices have an influence on suicide rates, independently of altitude. Clinicians working with Veterans who live at high altitudes should include all relevant elements in a suicide risk assessment. Given that altitude may constitute an “invisible” added environmental risk factor, the standard elements of risk assessment and safety planning<sup>18</sup> remain as important as ever when working with Veterans who reside at higher altitudes.

**There is no single cause of suicide. It is often the result of a complex interaction of risk and protective factors at the individual, interpersonal, community, and societal levels. To prevent Veteran suicide, we must maximize protective factors and minimize risk factors at all of these levels.**

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