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Letter to the Editor

In Response to Avalanche Fatalities in the United States by Jekich et al

To the Editor:

We recently read the article by Jekich et al[1] on avalanche fatality trends and demographics in the United States. We are grateful that the wilderness medicine community is interested in these data and that researchers are willing to analyze them. The article did a good job tying some of the data back to increasing backcountry use, and we appreciate the authors' comments about how improved avalanche forecasting and education are likely helping to reduce fatalities. However, we believe the authors may have overlooked some underlying nuances in the data, leading to a few conclusions that contradict our observations as longtime avalanche workers. As such, we offer our own simple analyses of these data and our interpretation of the results in the hope that it will broaden the discussion of avalanche accidents and spur more research from the wilderness medicine community.

As Jekich et al[1] pointed out, the history of avalanche fatalities in the United States since 1950 is complicated by changing use patterns. We have found that a graph of the 5-year moving average better demonstrates the overall fatality trend (Figure 1). This shows that fatalities have not increased steadily and linearly, but rather in distinct steps. The data show that the number of fatalities remained low through the 1950s and 1960s, with the moving average around 5 to 6 per year. The first big jump in fatalities occurred during the 1970s, likely due to an increase in backcountry recreation. During this decade, backcountry avalanche centers were established in Denver, Salt Lake City, and Seattle (joining the existing center on Mount Washington in New Hampshire) to warn the public of avalanche risk. From the mid-1970s to the early 1990s, fatalities again leveled off to around 13 to 16 per year. The early 1990s saw the next big jump in avalanche fatalities. This jump accompanied explosive growth in backcountry recreation by both skiers and snowmobilers. Improved equipment allowed skiers and snowboarders to go farther and more efficiently in search of untracked snow, and many ski areas opened their boundaries, allowing easier access to the surrounding backcountry. Also in the 1990s, the development of the first true mountain snowmobiles allowed riders to access avalanche terrain during snowstorms and other periods of elevated avalanche danger. Between 1951 and 1990, only 14 snowmobilers died in avalanches, but by the late 1990s and early 2000s avalanches were killing more than 10 snowmobilers per year most winters. As backcountry use exploded and fatalities increased, the United States Department of Agriculture Forest Service partnered with the public to start backcountry avalanche centers in numerous communities throughout the western United States.

The pattern of increasing avalanche fatalities shifts around 1995, and an encouraging trend emerges in the data. Despite rapidly rising backcountry use, some of which is documented by Jekich et al,[1] the number of avalanche fatalities has stayed relatively stable at about 25 to 30 per year (Figure 1).

The stepped increases in the US avalanche fatality data make assessing trends in the entire dataset with

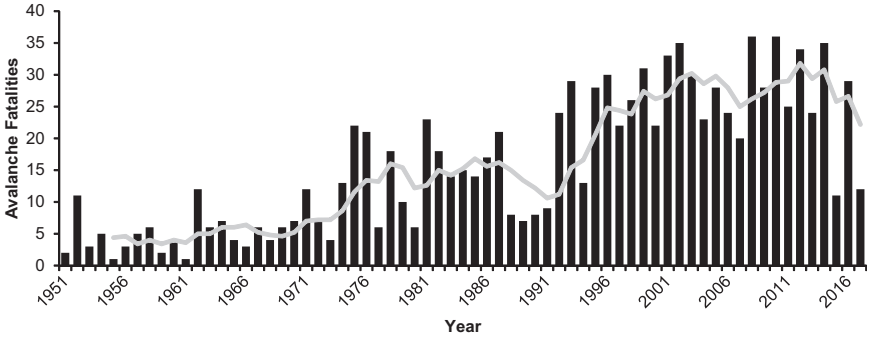

Figure 1. Avalanche fatalities in the United States have increased in a steplike manner, with the first large step occurring in the 1970s and the second large step in the early 1990s. Since 1995, the 5-year moving average (gray line) has mostly leveled, with fatalities ranging around 25 to 30 per year.

linear regression—as done by Jekich et al[1]—problematic. Such assessments assume a linear, monotonic trend. The existence of clear steps in the data violates that assumption; nonetheless, an analysis of the data between the steps can give us insights into trends during those time periods. Clearly, looking at avalanche fatality data since 1950 shows increasing fatalities. However, we are more interested in the *current* trends in avalanche fatalities to evaluate the effectiveness of our *current* strategies for protecting the public from avalanches. As such, we analyze the years from 1995 to the present. We selected 1995 as a starting point because by this time snowmobile technology allowed snowmobilers to regularly access avalanche starting zones, mountain snowmobiling was popular, and many small avalanche centers had been established and were providing increased levels of avalanche information and awareness in rural areas.

Interestingly, if we look at US avalanche fatalities since 1995, we see that they are not significantly increasing or decreasing ($P = .29$) (Figure 2). Instead, they are relatively consistent. This smaller dataset meets the assumptions required for regression analysis, including normally distributed data (Lilliefors $P > .2$), no evidence of heteroscedacity, and no obvious steps in the data. Two of the lowest-fatality years occurred in the last 3 years, but it will be several years before we know if this is just variability or if it constitutes a new trend. In addition, although the datasets are smaller, no statistically significant trend exists for either snowmobilers ($P = .40$) or skiers ($P = .16$) in the data since 1995. Our US results are consistent with European data, which also show relatively consistent numbers of avalanche fatalities in recent decades.[2]

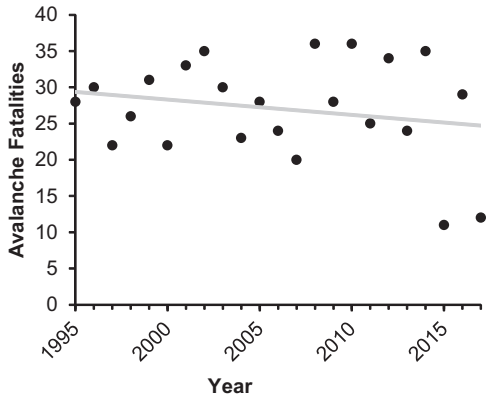

Figure 2. US avalanche fatalities since 1995 with a least squares line fit to the data. The appearance of a generally downward trend is likely due to the low-fatality years in 2014–2015 and 2016–2017. The trend is not statistically significant ($P = .29$), indicating that the current fatality trend is flat. The combination of this flat fatality trend and sizable increases in use demonstrates that the fatality rate has fallen dramatically during this period.

The trend in the recent data paints a different picture than that presented by Jekich et al.[1] Rather than an increase in avalanche fatalities, the data show a relatively flat trend over the past 23 seasons, with no statistically significant increases or decreases for overall fatalities, skier fatalities, or snowmobiler fatalities. This is despite, as highlighted by Jekich et al,[1] the dramatic increases in both population and backcountry use over that time period. As an imperfect proxy for backcountry use, we looked at our internal data on the changes in access to the avalanche advisories at various avalanche centers since 1995 and found that this use increased from 12-fold at the Utah Avalanche Center, to 17-fold at the Colorado Avalanche Information Center, to 36-fold at the smaller Gallatin National Forest Avalanche Center in Bozeman, Montana.

If we combine a conservative estimate of use increasing 8-fold since 1995 with our flat fatality trend, then our fatality rate has dropped dramatically. If our fatality rate had stayed constant, we might well be experiencing over 200 US avalanche fatalities each winter. We believe this is a big win for the entire avalanche community, including the manufacturers of improved avalanche safety equipment, the many dedicated avalanche educators, and the avalanche center network across the United States operated by the United States Department of Agriculture Forest Service and the State of Colorado that provides avalanche information and education to the public. The data support our belief that the avalanche community has developed appropriate tools and techniques to increase backcountry safety, and we simply need the resources to be able to continue to meet the rapidly increasing demand for our services.

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