

LETTERS

STATE-LEVEL RELATIONSHIPS CANNOT TELL US ANYTHING ABOUT INDIVIDUALS

Anderson et al.'s¹ finding that states with legalized medical marijuana had lower suicide rates among young men calls to mind the work of the famous French sociologist, Emile Durkheim. In *Le Suicide*,² published in 1897, Durkheim observed that suicide rates were lower in regions with a higher proportion of Catholics and concluded that social controls within the Catholic religion reduced the likelihood of Catholics taking their own lives. Durkheim's individual-level interpretation of his region-level data subsequently became a textbook example of the "ecological fallacy"^{3,4}; the assumption that associations observed at a higher level of aggregation (e.g., state level) are mirrored at the individual level.

Anderson et al. provide another example of the ecological fallacy when they suggest their findings are "consistent with the hypothesis that legalizing medical marijuana leads to increased marijuana use, which in turn helps individuals cope with stressful life events."¹(pp2369) In fact, their state-level data can tell us nothing about the relationship between individual-level medical marijuana use and

suicide risk. The state-level relationship observed does not mean that using medical marijuana protects against suicide, and if the state-level correlation had been in the opposite direction, it would not mean that using medical marijuana causes suicide either.

As nonintuitive as it sounds, relationships at different levels of aggregation are not necessarily parallel and indeed can go in opposite directions. For example, geographic areas with higher levels of smoking and radon exposure have lower cancer rates,^{5,6} but substantial data indicate smoking and radon put individuals at risk for cancer. We published a paper in this journal describing the ecological fallacy in the context of health care quality measures, illustrating how relationships between health care processes and outcomes can differ for groups and individuals.⁷ In Durkheim's case, it might have been that Catholics living in Protestant majority provinces drove the observed higher suicide rates observed there. In Anderson et al.'s case, the reduced suicide rate in states with medical marijuana could have been driven by young men who did not smoke medical marijuana.

The ecological fallacy is now well known in epidemiology and sociology, but is a persistent and unfortunately common problem in other areas of science. Often we have individual-level questions but only aggregate data, so we are tempted to make a seemingly logical, but erroneous, leap. Awareness of the ecological fallacy should give us pause in these situations. ■

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ANDERSON ET AL. RESPOND

In a study recently published by the journal,¹ we found that the legalization of medical marijuana was associated with a lower risk of suicide among young adult males. Harris et al. take us to task for having interpreted this association as evidence that marijuana "protects against suicide."

Our response to Harris et al.'s well-meaning, but misguided, critique is twofold. First, we did not interpret this association as evidence that marijuana protects against suicide. We simply noted that our results are consistent with the hypothesis that marijuana helps individuals cope with stressful life events. We also noted that legalizing medical marijuana could be related to suicides through alcohol consumption. We should have, but did not, mention that legalization could be related to suicides through substances

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aside from alcohol and marijuana. Anderson et al.² provide evidence that legalizing medical marijuana leads to reduced alcohol consumption among young adults; Bachhuber et al.³ provide evidence that legalizing medical marijuana reduces mortality due to opioid overdose.

Second, we agree with Harris et al. about the importance of individual-level data. However, it should be pointed out that an association between marijuana use and the risk of suicide at the individual level would not say much about the effect of marijuana on behavior. To estimate the causal relationship between these variables, we would need to find some method of isolating exogenous variation in marijuana use—for instance, by focusing on variation attributable to the adoption of a new policy or tax. In recent years, economists have increasingly come to rely on such natural experiments to estimate causal effects with observational data. Unfortunately, sociologists and epidemiologists have been slow to embrace the “Credibility Revolution.”⁴ Please view this response as an earnest and urgent invitation. ■

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