Characterization of population-level risk factors for suicide in US counties

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Methodological Question: What methods can address factors that underlie the observed geographic variability in suicide incidence and better define population characteristics that may contribute to suicide risk?

Introduction: Suicide rates vary markedly by geographic region for reasons that are incompletely understood. Since causative factors may also vary by location, a single statistical model may not adequately explain population suicide risk for all communities. Use of analytic methods that consider spatial distribution of variable relationships may provide information to guide research and policy.

Methods: We mapped mean incidence of suicide in US counties and performed bivariate correlation and exploratory regression analyses to assess population risks for suicide. Factors demonstrating the strongest relationship to suicide incidence were incorporated as independent variables in ordinary least squares (OLS) and geographically weighted regression (GWR) analyses.

Results: OLS regression analyses of nationwide suicide rates (2007-16) from all causes, firearms, hanging and medication/alcohol toxicity demonstrated adjusted R-squared values of 0.473 (all causes), 0.501 (firearms), 0.421 (hanging) and 0.352 (medication/alcohol toxicity, $p<0.001$ for all). Regression diagnostics demonstrated the presence of spatial non-stationarity, i.e. the OLS model did not meet regression assumptions due to spatial autocorrelation of residuals. To address this, GWR was performed using data from three sub-regions of the US that are characterized by marked variability in suicide incidence or ratio of firearm-to-non-firearm suicide, and that provided an adequate county sample for analysis of all-cause and firearm suicide.

GWR analysis of data from the first region – consisting of eight states of the intermountain west, i.e. the "suicide belt" – produced adjusted R-squared values of 0.401 and 0.655 for all-cause and firearm suicide, respectively; 0.641 and 0.888 for data from the second region (northern tier states of the midwest and eastern US); and 0.424 and 0.500 for the third region (states of the southeastern US) ($p<0.001$ for all). Significant explanatory variables included number of mentally unhealthy days in the past month (3 of 6 GWR models), number of physically unhealthy days in the past month (1 model), percent reporting heavy drinking (1 model), drug overdose mortality rate (incorporated as a proxy for unfavorable economic conditions, 3 models) and proxy measures for firearm ownership (fraction of suicides due to firearms (FSS), 5 models) or availability (prevalence of federally licensed firearms dealers, 1 model). A number of indicators having statistically significant associations with suicide rates in bivariate correlations were not independent predictors in multivariate models that best fit the data. These included racial/ethnic demographics, altitude, poverty, educational attainment and health care access indicators.

Conclusions: Multiple regression with geographic weighting supports the importance of factors related to mental health and availability of lethal methods to population suicide risk. Statistical

models based on nationwide data may be confounded by spatial influences on variable interrelationships. Geospatial analytic methods can contribute to research on the epidemiology of suicide and the improvement of local policies for suicide prevention.

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