County-level socioeconomic factors and residential racial, Hispanic, poverty, and unemployment segregation associated with drug overdose deaths in the United States, 2010-2015

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Context

The United States (US) has seen an increase of drug overdose deaths from 1999 to 2014, with an estimated 16.3 per 100,000 overdose deaths occurring in 2014, and overdose deaths have tracked along an exponential growth curve since at least the 1970s. There are considerable state-by-state differences in death rates, with highest rates observed in West Virginia, New Hampshire, Kentucky, Ohio, and Rhode Island and lowest rates in Iowa, Texas, North Dakota, South Dakota, and Nebraska. Notable county-level mortality variation exists within some states, such as ranges of too few to quantitate up to 81 per 100,000 in West Virginia, 79 per 100,000 in Kentucky, 23 per 100,000 in New Hampshire, and 28 per 100,000 in Texas.

Where people live influences health outcomes, including drug use and abuse. There are many factors that comprise environment, including physical conditions and social structure. Social structure takes on different forms, including absolute conditions (e.g. the proportion of people in poverty) and relative conditions (e.g. how the proportion of people in poverty in the near environment differ from the larger environment). Residential segregation reflects relative conditions. There is evidence to support that residential segregation may influence health outcomes differentially across social groups. For example, opposing directions of association across black and Hispanic groups have been observed for cardiovascular disease and birth outcomes, but little is known about residential segregation and drug abuse and associated conditions.

Most overdose deaths occur in individuals who have some sort of drug dependence disorder. Risk factors for drug addiction or dependence include family history, being male, co-existing mental health condition, peer pressure, lack of family involvement, and anxiety, depression, or loneliness. Several of these factors are known to be associated with social support. Residential segregation may serve as a proxy for social support, and the objective of this analysis was to evaluate overdose death rates in relation to county-level social, economic, and household characteristics and measures of residential segregation for race, Hispanic ethnicity, poverty, and unemployment.

Methodology

County-level overdose deaths were obtained from the Centers for Disease Control and Prevention (CDC Wonder) Underlying Cause of Death. Data for the years 2010-2015 for total deaths, deaths by race, and deaths by Hispanic ethnicity. Five-year data from the American Community Survey (2010-2014) were used to calculate measures of racial, ethnic, unemployment, and poverty segregation for dissimilarity, isolation, and diversity, using the method by Oka and Wong. Adjacent counties (touching by land border) and state were considered the larger geographic areas for each county.

Dissimilarity, as a measure of evenness, was calculated as the absolute value of the difference between (1) the composite population one group in the county (e.g.) divided by the composite population of that county plus the adjacent counties (or state) and (2) the composite population another group (e.g. black) in the county (e.g.) divided by the composite population of that county plus the adjacent counties (or state). Isolation was calculated as one minus (1) the difference in total population minus a group (e.g. black) at the county level divided by (2) the difference in total population minus the group population for the county and adjacent counties (or state). Diversity was calculated as the negative of the summation of the percentage of mutually exclusive groups multiplied by its natural logarithm.

The evaluation of overdose deaths at lower levels of geography is challenged by suppressed death counts (n<11). A two-prong approach was taken to evaluate residential segregation and total overdose deaths: (1) evaluation in counties with >10 deaths (n=2067), and (2) evaluation in all counties with deaths imputed for counties with <11 deaths (n=3142). Imputed for white, black, and Hispanic deaths provided unlikely rate estimates and imputed analyses were not further analyzed for these subgroups.

Negative binomial regression with death counts as the outcome variable and population count as the exposure were fit to calculate relative risks (incidence rate ratios) for residential segregation and county characteristics. Estimates of percent of population age >65 years and <18 years were included in the model to adjust for county-level age distribution. To evaluate whether residential effects on race and ethnic subgroups were different, an additional analysis was conducted to evaluate residential segregation and overdose deaths in counties that had >11 deaths for white, black, and Hispanic population (n=164). Separate multivariable models were fit to each type of segregation: race, Hispanic ethnicity, poverty, and unemployment for dissimilarity and diversity. Black, Hispanic, poverty, and unemployment isolation were highly correlated (Pearson r>0.95), and results for poverty isolation are presented as an overall representation of residential social isolation.

	Counties with >10 total deaths (n=2067)		With >10 deaths in white, black, and Hispanic subgroups (n=164)		Imputed total deaths (n=3142)	
Characteristic*	Mean (Min-Max)	IRR (95% CI)*	Mean (Min-Max)	IRR (95% CI)	Mean (Min-Max)	IRR (95% CI)
County-to-Adjacent County						
White-black dissimilarity	8.1 (0-57.1)	1.026 (1.015, 1.038)	14.6 (0-48.2)	1.017 (0.993, 1.041)	7.4 (0-97.5)	1.031 (1.015, 1.046)
Hispanic-NHW dissimilarity	5.3 (0-50.0)	1.005 (0.990, 1.021)	10.0 (0-43)	1.021 (0.991, 1.052)	4.9 (0-53.5)	0.998 (0.978, 1.019)
Poverty-nonpoverty dissimilarity	5.4 (0-52.9)	1.018 (1.004, 1.032)	13.3 (0-46.9)	1.022 (0.997, 1.047)	4.4 (0-53.0)	1.021 (1.002, 1.041)
Unemployed-others dissimilarity	4.2 (0-51.2)	1.006 (0.991, 1.022)	10.1 (0-39.9)	1.017 (0.989, 1.045)	3.6 (0-51.2)	1.014 (0.993, 1.036)
Poverty isolation	87.4 (53.0-99.8)	0.997 (0.985, 1.009)	79.2 (59.7-95.0)	0.986 (0.958, 1.015)	89.2 (53-100)	1.008 (0.991, 1.025)
County-to-State						
White-black dissimilarity	1.6 (0-58.3)	1.066 (1.043, 1.089)	7.4 (0-58.3)	1.026 (1.004, 1.049)	1.1 (0-58.3)	1.088 (1.053, 1.124)
Hispanic-NHW dissimilarity	1.1 (0-34.3)	1.081 (1.044, 1.120)	4.6 (0-34.3)	0.996 (0.962, 1.031)	0.8 (0-34.3)	1.112 (1.056, 1.172)
Poverty-nonpoverty dissimilarity	0.6 (0-17.9)	1.182 (1.102, 1.268)	2.3 (0-17.9)	1.088 (1.010, 1.172)	0.4 (0-17.9)	1.241 (1.120, 1.375)
Unemployed-others dissimilarity	0.3 (0-9.2)	1.410 (1.250, 1.590)	1.3 (0-9.2)	1.132 (0.990, 1.294)	0.3 (0-9.2)	1.524 (1.280, 1.814)
Poverty isolation	97.7 (0-100)	0.945 (0.928, 0.962)	90 (27.6-99.6)	0.973 (0.957, 0.990)	98.4 (0-100)	0.933 (0.908, 0.959)
Diversity						
Race diversity	47.8 (2.9-100)	0.994 (0.987, 1.001)	80.4 (36.9-100)	0.982 (0.962, 1.003)	44.0 (0-100)	0.993 (0.984, 1.002)
Hispanic diversity	54.1 (4.7-100)	1.006 (0.999, 1.013)	85.4 (49.3-100)	1.005 (0.981, 1.029)	51.4 (1.3-100)	1.000 (0.991, 1.009)
Unemployed diversity	17.5 (4.1-32.3)	0.930 (0.839, 1.030)	19.4 (12.9-27.3)	1.358 (0.879, 2.097)	16.2 (0-40.3)	0.807 (0.699, 0.931)
Poverty diversity	43.4 (16.2-69.2)	1.101 (1.039, 1.167)	40.8 (21.6-60.8)	1.062 (0.889, 1.268)	42.9 (5.8-69.2)	1.054 (0.978, 1.137)

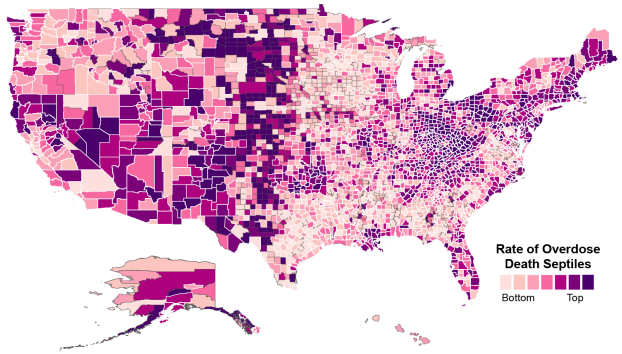
Results

There were 2067 counties with more than 10 overdose deaths in total (66% of total counties), and the mean crude death rate was 16.1 per 100,000. Similar mean death rates were observed in the counties with that had at least 10 deaths for white, black, and Hispanic populations (at least 10 in each group), with rates of 15.3 per 100,000 for total, 17.4 per 100,000 for white, 11.7 per 100,000 for black, and 8.1 per 100,000 for Hispanic. In counties with at least 10 overdose deaths, total overdose death rate ranged from 2.5 to 97.64 per 100,000. Highest values were clustered in the West, West South Central, and Appalachia parts of the US (See Map at Right).

We ran our models with only counties with greater than 10 deaths, and also using an imputation counties with <10 deaths (Table Above). In counties with >10 total deaths, overdose death rate was significantly, positively associated with county-level percent unemployment, mean per capita income, percent civilian disabled, and percent uninsured, with adjustment for the other county-level social characteristics. Significant inverse associations were observed for percent age 65 and older, age 17 and younger, racial/ethnicity minority, housing that was mobile homes, and housing that was group quarters.

Residential segregation measures were significantly associated with total overdose death rates (Table Above), adjusted for other county-level socioeconomic factors. The strongest association was observed for unemployment dissimilarity, with a 5-unit increase being associated with 40% higher death rate (IRR=1.410, 95% CI: 1.250, 1.590). Results were similar, magnitude and statistical significance, for imputed data. When stratified by race and Hispanic ethnicity (Table below), there were some notable similar and dissimilar associations with county-level residential segregation for county-to-adjacent county comparisons in counties with >10 white deaths, adjusted for other county-level socioeconomic factors.

	White		Black		Hispanic	
Characteristic*	>10 white deaths (n=2015)	With >10 white, black, and Hispanic deaths (n=164)	>10 black deaths (n=308)	With >10 white, black, and Hispanic deaths (n=164)	>10 Hispanic deaths (n=255)	With >10 Hispanic, black, and Hispanic deaths (n=164)
County-to-Adjacent County						
White-black dissimilarity	1.023 (1.012, 1.034)	1.017 (0.992, 1.042)	1.012 (0.987, 1.037)	1.039 (1.004, 1.075)	0.982 (0.947, 1.018)	0.979 (0.940, 1.019)
Hispanic-NHW dissimilarity	1.007 (0.992, 1.023)	1.030 (0.999, 1.062)	0.990 (0.953, 1.028)	0.993 (0.950, 1.037)	0.971 (0.928, 1.016)	0.984 (0.937, 1.034)
Poverty-nonpoverty dissimilarity	1.011 (0.998, 1.024)	1.015 (0.990, 1.040)	1.038 (1.008, 1.068)	1.048 (1.013, 1.085)	0.988 (0.956, 1.021)	0.995 (0.955, 1.036)
Unemployed-others dissimilarity	0.999 (0.984, 1.014)	1.008 (0.980, 1.037)	1.037 (1.003, 1.072)	1.049 (1.010, 1.091)	0.988 (0.952, 1.024)	0.997 (0.953, 1.043)
Poverty isolation	0.996 (0.984, 1.007)	0.992 (0.963, 1.022)	0.995 (0.961, 1.030)	0.962 (0.923, 1.003)	1.005 (0.968, 1.045)	0.972 (0.927, 1.019)
County-to-State						
White-black dissimilarity	1.063 (1.041, 1.086)	1.028 (1.005, 1.052)	1.054 (1.023, 1.087)	1.030 (0.999, 1.063)	1.010 (0.974, 1.049)	1.002 (0.967, 1.040)
Hispanic-NHW dissimilarity	1.077 (1.041, 1.114)	1.000 (0.964, 1.036)	1.020 (0.970, 1.072)	0.994 (0.947, 1.043)	0.979 (0.928, 1.034)	0.967 (0.915, 1.021)
Poverty-nonpoverty dissimilarity	1.165 (1.088, 1.248)	1.085 (1.004, 1.171)	1.093 (0.988, 1.209)	1.022 (0.919, 1.137)	1.009 (0.891, 1.142)	1.071 (0.947, 1.212)
Unemployed-others dissimilarity	1.370 (1.218, 1.541)	1.128 (0.982, 1.296)	1.461 (1.219, 1.751)	1.242 (1.024, 1.507)	0.997 (0.800, 1.243)	1.006 (0.813, 1.245)
Poverty isolation	0.950 (0.933, 0.967)	0.975 (0.958, 0.992)	0.965 (0.944, 0.986)	0.977 (0.954, 1.001)	0.969 (0.940, 0.998)	0.967 (0.941, 0.994)
Diversity						
Race diversity	1.000 (0.993, 1.007)	0.997 (0.975, 1.019)	0.956 (0.932, 0.981)	0.959 (0.929, 0.990)	0.938 (0.916, 0.960)	0.942 (0.909, 0.975)
Hispanic diversity	1.005 (0.998, 1.012)	1.012 (0.988, 1.037)	0.973 (0.948, 0.999)	0.968 (0.935, 1.002)	0.955 (0.933, 0.979)	0.991 (0.952, 1.032)
Unemployed diversity	0.891 (0.804, 0.988)	1.309 (0.839, 2.040)	1.061 (0.685, 1.644)	1.430 (0.741, 2.761)	1.754 (1.074, 2.866)	1.370 (0.664, 2.828)
Poverty diversity	1.060 (0.999, 1.125)	1.019 (0.848, 1.224)	1.392 (1.153, 1.679)	1.328 (1.029, 1.714)	1.081 (0.870, 1.343)	1.191 (0.887, 1.599)



Implications

For some of the associations, the magnitude of association was stronger for the county-to-state segregation measure than the county-to-adjacent county segregation measure. This difference between county-to-adjacent county and county-to-state may also reflect differences in overall ranges in values of residential segregation and diversity measures across the two larger geographic comparison areas. Differences that were observed were between significant and non-significant in the same direction, suggesting that both geographic levels support similar theoretical effects of county residential segregation influence.

Racial dissimilarity has been associated with other adverse health outcomes, however, in this analysis, there were few associations with black death rates; only county-to-state white-black dissimilarity was significantly associated, independent of other socioeconomic characteristics of the counties. This may support that structural racism specific to black individuals is more important to blacks than individual socioeconomic characteristics. Dissimilarity and isolation associations were more similar across white and black death rates than Hispanic death rates; whereas, measures of diversity associations were more similar across black and Hispanic death rates than white death rates. For Hispanic death rates, few associations were statistically significant, but this may represent lack of statistical power for the smaller number of counties that had usable data. There is limited work related to overdose deaths or drug use, but some studies have evaluated mental health outcomes and residential segregation in Hispanic groups. One possible mechanisms for differences across these studies are possible differences by Hispanic ethnicity subgroups (e.g. Cuban, Puerto Rican, Mexican).

Some socioeconomic drivers of drug overdose deaths were consistent across race and Hispanic groups, and other factors differed across the groups. Consistent positive associations included percent civilian disabled, and consistent inverse associations included percentages of age 65 and older and age 17 and younger. Inverse associations with higher proportions of older and younger groups may reflect that these groups are less likely to be drug users, as drug use is highest in late teens and early twenties. Some interesting associations that were discordant across the groups included percent poverty, per capita income, percent single parent households, percent racial/ethnicity minority, mobile homes, and percent uninsured. The subsample analysis indicated that these relationships are unlikely to be entirely explained by the differences in which counties have sufficient data for white, black, or Hispanic overdose deaths, but the difference in health outcome and individual level vs. ecological level analysis may be a driving factor.

These results suggest residential segregation may exert independent effects on drug overdose mortality beyond county socioeconomic characteristics, and effects differ across race and ethnic groups. Residential segregation may offer insight into the socioeconomic well-being of a group. Other factors that may be influential include access to drug addiction resources or normalized beliefs about drug use in spatially similar populations. Alternatively, cultural or social characteristics of a group may strength in isolated communities and provide a foundation for social support.