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Abstract

A County-Level Analysis of the Association of Social Determinants and Age-Adjusted Suicide

Rates in the State of Georgia, 2000-2019

by

Taylor Jones

July 1, 2022

Introduction: Suicide rates in the United States continue to increase and are a significant public health concern. Suicide is the 10th leading cause of death in Georgia and is largely preventable. Georgia (GA) ranks low for mental health care access which influences mental health outcomes such as suicide. In addition, understanding data on social determinants of health may have implications for the role that they may play in suicide and could help us to understand ways to improve health equity and poor mental health outcomes.

Aim: The purpose of this study was to examine trends in suicide deaths in GA counties and assess the association between age-adjusted suicide rates and social determinants across urban and rural counties of GA over a 20-year period.

Methods: CDC WONDER was used to request age-adjusted suicide rates from 2000 to 2019 among Georgia residents at the county level. Suicide death data was derived from death certificates using ICD-10 underlying cause-of-death codes U03, X60-X84, and Y87.0. A literature review was conducted to determine social determinants associated with suicidal behavior. The US Census Bureau database was used to query indicator data of the ten social determinant factors chosen from the literature review. Linear regression analyses were

conducted to evaluate the association between selected indicators and age-adjusted suicide rates at the county level over two periods, 2000-2009 and 2010-2019.

Results: A total of 159 counties in Georgia were analyzed in this study. There are 74 urban counties and 85 rural counties. In 2000, bivariate results indicate that race, ethnicity, education, employment, income, and urbanization were associated with age-adjusted suicide rates. The bivariate analysis results of 2010 data show that race, ethnicity, education, and poverty were associated with age-adjusted suicide rates. In the multivariate analyses, none of the variables were statically significant associated with age-adjusted suicide rates. There was multicollinearity observed among the independent variables.

Discussion: While bivariate associations between variables and age-adjusted suicide rate were identified, none remained statistically significant in a multivariate linear regression model. This change may be attributed to multicollinearity, making it challenging to estimate regression coefficients reliably. Percent population White, percent population non-Hispanic, percent population employed, and urbanization are factors that were statistically significant and positively correlated with increased age-adjusted suicide rates in the 2000 & 2010 bivariate analyses and should still be considered as possible factors that influence suicide rates.

A County-Level Analysis of the Association of Social Determinants and Age-Adjusted Suicide
Rates in the State of Georgia, 2000-2019

by

Taylor Jones

B.S., Georgia State University

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment

of the

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Atlanta, Georgia

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Approval page

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Rates in the State of Georgia, 2000-2019

by

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Author's Statement Page

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Taylor Jones

Signature of Author

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Introduction

1.1 Background

Suicide is a major public health concern and is a global issue in all regions of the world. It is a complicated issue that affects many lives every year and leaves lasting effects on the friends, loved ones, and community of those who have died by suicide and attempted suicide. In 2019, suicide was the 10th leading cause of death in the United States and in the state of Georgia. From 1999 to 2019, there were nearly 800,000 suicide deaths, with a 33% increase in the suicide rate during this period in the US (Stone, 2021). In high-income countries such as the US, suicide and mental disorders are linked, and suicide often occurs in moments of crisis when dealing with life stresses, financial problems, chronic pain, or illness (WHO, 2021).

While suicide is considered preventable, it requires a comprehensive approach and understanding of the several factors contributing to the increased risk of attempting suicide. These include individual physical, psychological, and environmental influences and demographic characteristics. Understanding these risk factors allows for suicide prevention activities to be designed to be tailored to different groups at risk in the population. Examining factors associated with suicide trends is necessary to inform policies and programs that target efforts to increase or decrease suicide risk in vulnerable communities. In the US, suicide rates are highest among non-Hispanic White populations. While factors linked to suicide disproportionately affect those living in rural areas and minorities.

Georgia is a state with broad geographical, racial, and ethnic diversity. There are 159 counties in Georgia, and more than half are considered rural counties. Suicide in Georgia affects specific demographic groups disproportionately, with the greatest burden in rural counties (Hill, 2022). Georgia continuously ranks low for mental health care access and has a history of health

disparities between communities (Associated Press, 2022). There is limited research on factors associated with suicide deaths in Georgia.

1.2 Study purpose

The purpose of this study is to assess the relationship between age-adjusted suicide rates and social determinants of health across urban and rural populations in the State of Georgia from 2000 to 2019. This analysis aims to determine the strength of association between race, ethnicity, education, employment, income, and poverty level with suicide at the county level in the study population. It is hypothesized that a strong association exists between race, income level, poverty, and suicide. This analysis contributes to research on suicide by identifying factors that disproportionately contribute to suicide rates.

Literature Review

2.1 Social Determinants of Health

In Georgia, the age-adjusted suicide rate was highest in 2018 and 2019, with a rate of 14.6 per 100,000 (CDC Wonder, 2022). The age-adjusted suicide rate in Georgia is lower than the national average, but it increases yearly (DBHDD, 2022). Georgia is known for its geographic and racial diversity, but the burden of suicide disproportionately affects people of lower socioeconomic backgrounds (CDC, 2022). Georgia ranks low for mental health care access which influences mental health outcomes such as suicide. Understanding data on social determinants of health may have implications on health equity by reducing disparities in access and outcomes (Deferio, 2019). Suicide mortality varies across social determinants of health, including age, sex, race, marital status, income, educational attainment, and employment status (Miller, 2012).

Research on racial and ethnic differences in suicide is limited, but it is known that suicide is unevenly distributed across demographics. Age-adjusted suicide rates for White and American Indian people reflect a decrease during 2000-2019, while rates for Black and Asian individuals have increased (Ramchand, 2021). There has also been a 79.7% increase in suicide attempts among Black adolescents between 1991 and 2019, which is disproportionate to other racial and ethnic groups (Xiao, 2021). They are more likely to experience socioeconomic inequities and adverse life experiences, which may account for the disparity in suicide rates (Xiao, 2021). As of 2009, female adolescents have experienced increased suicidal ideation in the US (Xiao, 2021). Suicide attempts and ideation are important risk factors for suicide in the general population. (WHO, 2021)

There is sufficient evidence linking access to educational and employment opportunities and poor mental health outcomes (Alegria, 2018). High educational attainment is associated with lower suicide risk among men, while low attainment is associated with increased risk in men and women (Øien-Ødegaard, 2021). From 2000 to 2014, people with at least a college degree exhibited lower suicide rates than those with a high school degree (Phillips, 2017). However, the association between education and suicide risk is not linear. It is determined that those that experience more interpersonal problems are more likely not to have a college degree which may influence this association (Phillips, 2017). Job inconsistencies are more present among those who commit suicide compared to those with a college degree (Phillips, 2017). Unemployed women in the US have been observed to have higher deaths from suicide than unemployed men (Kposowa, 2019).

In 2019, 31 % of Georgia adults ages 25 and older had a bachelor's degree or above. Educational attainment is highest in metro Atlanta counties and lower in rural counties (Lee, 2019). Higher county-level poverty concentration is associated with higher pediatric suicide rates (Hoffman, 2020). Income inequality and poverty are risk factors for suicidal thoughts and suicide (Hoffman, 2020). Poverty is said to be negatively associated with suicide in the United States (Lee, 2021).

2.2 Geographical Differences

Suicides in the United States have increased, with the highest percentages of increase seen in rural counties (CDC, 2018). Rural areas have higher age-adjusted suicide rates, reflecting cultural, economic, and social factors contributing to suicide risk (Barnhorst, 2021). Other risk factors include access to mental health care and firearms, which vary in rural and urban areas (Barnhorst, 2021).

Those with mental illness are two to six times more likely than the general population to commit suicide (Reeves, 2013). Access to mental health practitioners and services tends to be limited in rural areas (Morales, 2020). There is also a stigma surrounding the use of mental health care in rural areas. Rural residents who sought professional help for depressive symptoms are labelled more negatively than their urban counterparts. (Ross, 1993)

Rural areas also have higher use of firearms, and access to firearms is a risk factor for suicide and accounts for many suicide deaths (Jennissen, 2021). Many rural counties rely on mining, agriculture, or manufacturing. The economic gap between urban and rural communities continues to widen (Lichter, 2017). Rural communities are experiencing more agricultural and economic strain. This strain results in fewer employment opportunities and job inconsistencies is a risk factor for suicide (Ramchand, 2022).

Georgia's landmass is mostly rural; however, the majority of Georgia's population does not reside in rural areas (Amy, 2021). As Georgia becomes more diverse and urbanized, there is a population shift toward metro Atlanta and away from rural counties (Amy, 2021). Despite an increase in urbanization, according to the Department of Behavioral Health, from 2019 to 2020, there was an over 8% increase in suicide in rural areas of Georgia (Hill, 2022).

Methods

3.1 Outcome Measure

The suicide death data for Georgia counties was obtained from the CDC WONDER, Underlying Cause of Death Database for 2000-2019. This database contains mortality counts provided by the National Vital Statistics System (NVSS) for all US counties, based on death certificates for US residents. Death certificates identify a single underlying cause of death and demographic data.

Age-adjusted death rates were calculated using the direct method and age-adjusted to the 2000 standard population using population estimates by the US Census Bureau in the CDC WONDER, Underlying Cause of Death Database. Suicide data was chosen with death certificates using the International Classification of Disease, Tenth Revision (ICD-10) underlying cause-of-death codes for intentional self-harm (suicide) (U03, X60-X84, Y87.0). This query produced the number of suicide deaths, urbanization codes, age-adjusted suicide death rates per 100,000 population with 95% confidence intervals, and standard errors for 2000–2019 and 159 counties in Georgia. Missing age-adjusted rates were suppressed or unreliable. Data is suppressed when the suicide death count is 0-9 persons. Data is considered unreliable when death rates have a numerator of 20 or less.

3.2 County Variables

Relevant literature was reviewed to identify the social determinants with a theoretical basis for potential association with suicide. County-level social determinant indicator data was gathered from the US Census Bureau database. The downloaded data file included data on racial/ethnic groups, educational attainment, employment, labor force status, income, and poverty from the Decennial Census and American Community Survey (ACS). The decennial

census is conducted every ten years, counting every person in the 50 states, the District of Columbia, and 5 US territories, and provides an official count of the population. This collected age, sex, race, ethnicity, and homeowner/renter status data. The American Community Survey is conducted monthly and yearly for a sample of about 3.5 million addresses in the 50 states, the District of Columbia, and Puerto Rico. It provides data on education, employment, transportation, etc.

This study used Decennial Census data for 2000-2009 and ACS 5-year estimates for 2010-2019, which provided the most reliable information for small populations such as county-level. The indicators selected for the analysis were the total white population, total black population, total Hispanic or Latino population, percent population 25 years and over with high school graduate or higher, percent population 25 years and over with bachelor's degree or higher, percent population 16 years and over unemployed and in the civilian labor force, median household income, mean household income, percent of families below the poverty level for 2000 and 2010.

3.3 Data Processing and Measures

The data was downloaded and merged into Microsoft Excel Workbooks. The outcome variable was county-level age-adjusted suicide rates per 100,000 over the time period 2000-2019. Geographic information was obtained from urbanization codes based on the 2013 National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for counties in GA. When applicable, totals were converted to percentages using total population counts per county. These percentages were oriented in the same direction by subtracting the percentage from 100% where necessary. The independent variables were percent population White, percent population Black, percent population Hispanic, percent population non-Hispanic, percent population 25 and

older high school graduates and higher, percent population with bachelor's degree or higher, percent population 16 years and over unemployed and in the civilian labor force, median household income, mean household income, percent of families below the poverty level for 2000 and 2010.

The merged dataset was then imported into SAS software, version 9.4. County-level age-adjusted data suppressed or unreliable are reclassified as missing= (.). The urbanization code was coded as a dichotomous variable. This variable indicates geographic location. Urbanization codes 1-4 were categorized as 1=urban, and codes 5-6 were categorized as 2=rural. Urban counties are in metropolitan statistical areas, while rural counties are in micropolitan statistical areas or nonmetropolitan counties.

3.4 Statistical Analysis

After data cleaning, a descriptive analysis of the variables used in the model was performed in the SAS 9.4 for 2000-2009 and 2010-2019. A bivariate Pearson Correlation analysis was conducted to assess the strength of the linear relationship between each independent variable and the age-adjusted suicide rate at the county level. Also, a bivariate linear regression analysis was conducted to estimate parameters in a linear equation that could be used to predict the age-adjusted suicide rate based on values of the social determinant.

The general formula of the bivariate linear regression model is given as follows:

$$y_i = \beta_0 + \beta_1 x_i + e_i$$

A multivariate regression analysis was used to test the association and significance of trends in independent variables together with the age-adjusted suicide rate for the time period 2000–2009 and 2010-2019. This model only included statistically significant variables from the bivariate models to increase the model's precision. A probability level (p-value) of <.05 was used to

determine the significance of associations between county-level variables and the age-adjusted suicide rates.

Collinearity diagnostics result was assessed to test for multicollinearity among the independent variables in the multivariate linear regression model. The diagnostic was performed using SAS 9.4. The proportion of the variance and condition index was produced to assess multicollinearity.

Another multivariate regression analysis was conducted using geographical stratification. Counties were stratified according to their geographic status using the 2013 National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for counties and coded into dichotomous variables, 1=urban and 2=rural. This method accounted for urban and rural disparities in suicide rates.

The general formula of the multivariate linear regression model is given as follows:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_n$$

In this formula, “y” is the outcome variable; $\beta_0, \beta_1, \beta_2, \dots, \beta_k$ are the unknown parameters estimated by the regression model; and x_1, x_2, \dots, x_n are independent covariates variables.

Chapter IV- Results

4.1 Descriptive analysis

There are 159 counties in Georgia. However, 54 and 44 counties in 2000-2009 and 2010-2019, respectively, had missing rates due to suppressed or reliable data. A total of 105 counties and 115 counties were included in the dataset for analysis of 2000-2009 and 2010-2019, respectively. Variable descriptions and sources are presented in Table 1. Descriptive statistics, including means and standard deviations, are shown in Table 2. The mean age-adjusted suicide rate of included counties in GA increased from 12.94 ± 2.90 to 15.33 ± 3.40 (per 100,000) from 2000-2009 to 2010-2019.

Towns County (21.9 age-adjusted rate), Haralson County (21.7 age-adjusted rate), and Jasper County (21.5 age-adjusted rate) were the counties with the highest age-adjusted suicide rates in 2000-2009, while Dawson County (31.1 age-adjusted rate), Union County (24.2 age-adjusted rate), and Pickens County (23.2 age-adjusted rate) were the highest in 2010-2019. Shown in Figure 1 is the comparison of age-adjusted suicide rates over time for those counties where the data was not censored.

Counties were also sorted by their public health districts to compare districts' changes in age-adjusted suicide rates over time periods, as pictured in Figure 2. All health districts show an increase in age-adjusted rates except for South Central and North Central districts, where several counties have suppressed and unreliable death rates that were not included in the analysis.

4.2 Pearson correlation

Table 3 shows a summary of the bivariate Pearson Correlation results. In 2000-2009, of the 11 variables analyzed, ten demonstrated statistically significant associations with the age-adjusted suicide rate. Of the ten statistically significant variables, percent population White,

percent population non-Hispanic, percent population employed, and urbanization were positively correlated. A positive direction of the standardized coefficient suggests that a higher independent variable value is associated with higher age-adjusted suicide rates. The remainder of the statistically significant variables, percent population Black, percent population Hispanic, percent population with a high school diploma or higher, percent population with a bachelor's degree or higher, median income, and mean income had a negative correlation. A negative standardized coefficient suggests that a lower independent variable value is associated with higher age-adjusted suicide rates.

In 2010-2019, of the 11 variables analyzed, five variables demonstrated statistically significant associations with the age-adjusted suicide rate. Of the five statistically significant variables, percent population White and percent population non-Hispanic were positively correlated. The remainder of the statistically significant variables, percent population Black, percent population Hispanic, and percent population with a bachelor's degree or higher had a negative correlation.

Strong linear relationships have Pearson correlation coefficients (r) between ± 0.40 & ± 0.60 , moderate r values are between ± 0.30 & ± 0.39 , and weak r values are between ± 0.20 & ± 0.29 . In both time periods, percent population White (2000: $r = 0.548$; 2010: $r = 0.613$) and percent population Black (2000: $r = -0.456$; 2010: $r = -0.555$) show strong linear relationships with age-adjusted suicide rates, while the remaining variables displayed moderate to weak linear relationships with the outcome.

4.3 Bivariate linear regression analysis

The bivariate linear regression analysis shown in Table 3 displays the standardized coefficients, which describe the size of the effect the independent variables are having on the age-adjusted suicide rate. In 2000 and 2010, the geographic location had the largest standardized coefficient of 1.379 and 0.752, respectively, having the largest effect on the age-adjusted suicide rate. Percent population White, non-Hispanic, and employed all had positive coefficients in 2000. The same variables, in addition to percent below poverty level, had a positive coefficient in 2010.

4.4 Multivariate regression analysis

The results of the multivariate linear regression analysis are shown in Table 6. In this analysis, the overall models in 2000 and 2010 were significant, with a p-value of $<.0001$. The 2000 and 2010 models did not contain any statistically significant variables. In Table 7, the multivariate linear regression analysis is stratified by geographic locations, urban and rural.

4.5 Collinearity Diagnostics

The collinearity diagnostics results are represented in table 8 and table 9. In 2000, the proportion of variances of all variables in the model, except urbanization, were associated with high condition indices of 55.29, 61.10, 114.13, 204.34, and 624.08. In 2010, all included variables, except the percent population with a bachelor's degree or higher, were associated with high condition indices of 57.23, 99.88, 276.44, and 298.75. This analysis used 30 as the threshold that warrants further investigation. For each row with a large condition, index variables with a proportion of variance greater than 0.5 are considered to contribute to collinearity.

Chapter V- Discussion

Suicide is a major public health concern and there has been a 33% increase in the suicide rate during 1999 to 2019 in the US (Stone, 2021). In 2018 and 2019, suicide was the 10th leading cause of death in the US and in the state of Georgia (DBHDD, 2022). It is important to understand factors that may contribute to the increase in suicide. Currently, there is limited research on factors associated with suicide deaths in Georgia. This study aimed to evaluate the associations of race, ethnicity, employment, income, education, and poverty level on the age-adjusted suicide rates among urban and rural counties in Georgia.

Many of the selected social determinants of health were significantly associated with suicide death in the bivariate analysis. In 2000, percent population White, non-Hispanic, and employed were statistically significant and positively correlated with age-adjusted suicide rate. These findings align with similar studies conducted in 1986 where Caucasians with at least a high school education were more likely to commit suicide than those with less than a high school education (Kung, 1998). However, another similar study conducted in 2001 concluded that educational attainment was negatively associated with suicide rates (Abel, 2005).

In 2010, the percent population White, percent population Black, percent population Hispanic, percent population with a bachelor's degree or higher, and percent population below poverty level were significantly associated with suicide death. Only percent population White, percent population with a bachelor's degree or higher and percent below poverty level were positively correlated with age-adjusted suicide rate. These findings were similar to a study conducted during the 2008-2009 recession which found that population risk of suicide was most clearly associated with county-level poverty rates (Kerr, 2017).

The same factors were not found to be significantly associated with suicide death in the multivariate analysis. In 2000 and 2010, there were no significant variables, but the overall models were significant, with p-values $<.0001$. This change in significance between the bivariate and multivariate analysis may be due to the presence of multicollinearity in the regression model. Collinearity can cause incorrect estimation of the standardized coefficient. High condition indices and variance proportion contribute strongly to the variance among all variables in the model except urbanization in 2000 and all variables except the percent population with a bachelor's degree or higher in 2010.

Although the results from these analyses do not support the hypothesis that a statistically significant association exists between race, income level, poverty, and suicide, the statistically significant factors from the bivariate analyses that were positively correlated with increased age-adjusted suicide death rates should still be considered as possible risk factors of suicide.

Percent population White, percent population non-Hispanic, and percent population employed are associated with increased age-adjusted suicide rates in the 2000 & 2010. The analysis results also indicated an increase in age-adjusted suicide rates in rural counties from 2000 to 2010.

Rural counties also had higher suicide rates when compared to urban counties. A study conducted during 2010-2018 among adults in the US also found that suicide rates are higher in areas with a shortage of mental health providers and communities with social and economic disadvantage (Ku, 2021). This supports the need for prevention efforts that target rural populations, which may include an effort to increase access to mental health providers and services and interventions to target persons of lower income levels and educational backgrounds.

5.1 Study strengths and limitations

Quantitative research allows for examination of possible correlation among social determinants and age-adjusted suicide rates. A strength of this study is that linear regression analyses was conducted to assess the linear relationship between social determinants and age-adjusted suicide rates. This was the best analysis to conduct due to the use of continuous variables.

An important limitation of this study was that some of the county-level outcome data were suppressed or unreliable. Data is suppressed when the count is 0-9 persons. Data is considered unreliable when death rates have a numerator of 20 or less. When there are 20 or fewer deaths, the relative standard error is 23% or more, which is statistically unreliable. Another limitation of this study is the assumption of a linear relationship between the independent variables and the outcome. It was also assumed that there was a normal distribution of the outcome variable. However, the results from the univariate analysis determined that the age-adjusted rates may not have met this assumption. It also needs to be stated that this study did not account for possible changes in suicide reporting or misclassification of deaths.

5.2 Future Implications

The findings of this study have important implications for helping to understand disparities in suicide behavior among urban and rural populations. Future research can further investigate how counties define suicide and changes in suicide reporting, which may account for changes in age-adjusted suicide rates over time. Differences in access to mental health care among urban and rural counties are another factor that should be considered when studying changes in suicide rates.

Chapter VI- Conclusion

While this study had conflicting findings, the analysis can still provide meaningful insight into how social determinants of health among populations can be associated with age-adjusted suicide rates. It is essential to understand how these factors affect communities to properly implement specific policies and programs that help to reduce suicide rates.

Understanding these factors will aid in a comprehensive approach to preventing suicide. Further studies should focus on understanding the differences in mental health care services and providers in urban and rural locations to improve inequities in access to care.

References

1. Stone, D. M., Jones, C. M., & Mack, K. A. (2021). Changes in Suicide Rates - United States, 2018-2019. *MMWR. Morbidity and mortality weekly report*, 70(8), 261–268.
<https://doi.org/10.15585/mmwr.mm7008a1>
2. World Health Organization. (2021, June 17). Suicide. <https://www.who.int/news-room/fact-sheets/detail/suicide>
3. Centers for Disease Control and Prevention. (2022, May 24). Facts about suicide. Centers for Disease Control and Prevention. Retrieved June 4, 2022, from <https://www.cdc.gov/suicide/facts/index.html#:~:text=Suicide%20rates%20increased%2030%25%20between,one%20death%20every%2011%20minutes.&text=The%20number%20of%20people%20who,attempt%20suicide%20is%20even%20higher.>
4. Hill, B. (2022, February 1). Suicide rates surge in rural Georgia, continue to climb in minority communities. *Fox 5 Atlanta*. <https://www.fox5atlanta.com/news/suicide-rates-continue-to-climb-in-minority-communities-surge-in-rural-georgia>
5. Press, A. (2022, March 8). Georgia House passes broad changes to mental health programs. *US News*. <https://www.usnews.com/news/best-states/georgia/articles/2022-03-08/georgia-house-passes-broad-changes-to-mental-health-programs>
United States Department of Health and Human Services (US DHHS), Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS), Underlying Cause of Death 1999-2020 on CDC WONDER Online Database, released 2021. Data are compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Accessed at <http://wonder.cdc.gov/ucd-icd10.html>. [last accessed 15 May 2022].

6. Georgia Department of Behavioral Health and Developmental Disabilities. (2022, January). Suicide in Georgia 2022. <https://dbhdd.georgia.gov/bh-prevention/suicide-prevention>
7. Deferio, J. J., Breitingner, S., Khullar, D., Sheth, A., & Pathak, J. (2019). Social determinants of health in mental health care and research: a case for greater inclusion. *Journal of the American Medical Informatics Association: JAMIA*, 26(8-9), 895–899. <https://doi.org/10.1093/jamia/ocz049>
8. Ramchand R, Gordon JA, Pearson JL. Trends in Suicide Rates by Race and Ethnicity in the United States. *JAMA Netw Open*. 2021;4(5):e2111563. doi:10.1001/jamanetworkopen.2021.11563
9. Xiao, Y., Cerel, J., & Mann, J. J. (2021). Temporal Trends in Suicidal Ideation and Attempts Among US Adolescents by Sex and Race/Ethnicity, 1991-2019. *JAMA network open*, 4(6), e2113513. <https://doi.org/10.1001/jamanetworkopen.2021.13513>
10. Øien-Ødegaard, C., Hauge, L. J., & Reneflot, A. (2021). Marital status, educational attainment, and suicide risk: a Norwegian register-based population study. *Population health metrics*, 19(1), 33. <https://doi.org/10.1186/s12963-021-00263-2>
11. Lee, J. (2021, March 23). 2019 Georgia Higher Education Data Book. Georgia Budget and Policy Institute. Retrieved May 16, 2022, from <https://gbpi.org/georgia-higher-education-data-book-2019/>
12. Phillips, J. A., & Hempstead, K. (2017). Differences in US Suicide Rates by Educational Attainment, 2000-2014. *American journal of preventive medicine*, 53(4), e123–e130. <https://doi.org/10.1016/j.amepre.2017.04.010>

13. Kposowa, A. J., Aly Ezzat, D., & Breault, K. (2019). New Findings On Gender: The Effects Of Employment Status On Suicide. *International journal of women's health*, 11, 569–575. <https://doi.org/10.2147/IJWH.S216504>
14. Hoffmann JA, Farrell CA, Monuteaux MC, Fleegler EW, Lee LK. Association of Pediatric Suicide With County-Level Poverty in the United States, 2007-2016. *JAMA Pediatr*. 2020;174(3):287–294. doi:10.1001/jamapediatrics.2019.5678
15. Centers for Disease Control and Prevention. (2018, January 12). Suicide in Rural America. Centers for Disease Control and Prevention. Retrieved June 4, 2022, <https://www.cdc.gov/ruralhealth/Suicide.html>
16. Lee, H., Park, C., Rhee, S. J., Kim, B., Lee, S. S., Ha, K., Baik, C. J., & Ahn, Y. M. (2021). The influence of poverty attribution on attitudes toward suicide and suicidal thought: A cross-national comparison between South Korean, Japanese, and American populations. *Comprehensive psychiatry*, 109, 152259. <https://doi.org/10.1016/j.comppsy.2021.152259>
17. Hoffmann, J. A., Farrell, C. A., Monuteaux, M. C., Fleegler, E. W., & Lee, L. K. (2020). Association of Pediatric Suicide With County-Level Poverty in the United States, 2007-2016. *JAMA pediatrics*, 174(3), 287–294. <https://doi.org/10.1001/jamapediatrics.2019.5678>
18. Barnhorst, A., Gonzales, H., & Asif-Sattar, R. (2021). Suicide prevention efforts in the United States and their effectiveness. *Current opinion in psychiatry*, 34(3), 299–305. <https://doi.org/10.1097/YCO.0000000000000682>

19. Reeves, W.C., Lin, J.M.S. & Nater, U.M. Mental illness in metropolitan, urban and rural Georgia populations. *BMC Public Health* **13**, 414 (2013). <https://doi.org/10.1186/1471-2458-13-414>
20. Morales, D. A., Barksdale, C. L., & Beckel-Mitchener, A. C. (2020). A call to action to address rural mental health disparities. *Journal of clinical and translational science*, *4*(5), 463–467. <https://doi.org/10.1017/cts.2020.42>
21. Rost, K., Smith, G. R., & Taylor, J. L. (1993). Rural-urban differences in stigma and the use of care for depressive disorders. *The Journal of rural health : official journal of the American Rural Health Association and the National Rural Health Care Association*, *9*(1), 57–62. <https://doi.org/10.1111/j.1748-0361.1993.tb00495.x>
22. Lichter, D. T., & Ziliak, J. P. (2017). The Rural-Urban Interface: New Patterns of Spatial Interdependence and Inequality in America. *The ANNALS of the American Academy of Political and Social Science*, *672*(1), 6–25. <https://doi.org/10.1177/0002716217714180>
23. Ramchand, R., Ayer, L., O'Connor, S. (2022). Unemployment, Behavioral Health, And Suicide, Health Affairs Health Policy Brief. DOI: 10.1377/hpb20220302.274862
24. Jennissen, C. A., Wetjen, K. M., Wymore, C. C., Stange, N. R., Denning, G. M., Liao, J., & Wood, K. E. (2021). Firearm Exposure and Storage Practices in the Homes of Rural Adolescents. *The western journal of emergency medicine*, *22*(3), 498–509. <https://doi.org/10.5811/westjem.2021.3.50263>
25. Amy, J. (2021, August 12). Georgia gets more urban and diverse as white residents dip. *Associated Press*. Retrieved June 20, 2022, from <https://apnews.com/article/georgia-census-2020-234b0a23975b19f682cf37a2517ee364>

26. Abel, E. L., & Kruger, M. L. (2005). Educational Attainment and Suicide Rates in the United States. *Psychological Reports*, 97(1), 25–28. <https://doi.org/10.2466/pr0.97.1.25-28>
27. Kerr, W. C., Kaplan, M. S., Huguet, N., Caetano, R., Giesbrecht, N., & McFarland, B. H. (2017). Economic Recession, Alcohol, and Suicide Rates: Comparative Effects of Poverty, Foreclosure, and Job Loss. *American journal of preventive medicine*, 52(4), 469–475. <https://doi.org/10.1016/j.amepre.2016.09.021>
28. Ku, B. S., Li, J., Cathy Lally, Compton, M. T., & Druss, B. G. (2021). Associations between mental health shortage areas and county-level suicide rates among adults aged 25 and older in the USA, 2010 to 2018. *General hospital psychiatry*, 70, 44–50. <https://doi.org/10.1016/j.genhosppsy.2021.02.001>

Appendix

Table 1. Variables used for this study, description, metric, sources and years. All the variables are aggregated over time period 2000-2009 and 2010-2019 at the county level

Variable name	Description	Metric	Sources	Years
Outcome variable				
Age-adjusted suicide rates	Proportion of population that died from suicide according to their death certificates by county aggregated over 2000-2009 and 2010-2019 controlling for differences in population age distribution	Continuous	“Underlying cause of death, 1999-2020” from CDC WONDER website	2000-2009 & 2010-2019
Predictor Variables				
Percent population White	Proportion of white population	Continuous	US Census Bureau	2000 & 2010
Percent population Black	Proportion of black population	Continuous	US Census Bureau	2000 & 2010
Percent population Hispanic	Proportion of Hispanic population	Continuous	US Census Bureau	2000 & 2010
Percent population non-Hispanic	Proportion of non-Hispanic population	Continuous	US Census Bureau	2000 & 2010
Percent population with high school diploma or higher	Proportion of population >25 with high school diploma or higher	Continuous	US Census Bureau	2000 & 2010
Percent population with bachelor’s degree or higher	Proportion of population >25 with bachelor’s degree or higher	Continuous	US Census Bureau	2000 & 2010
Percent population employed	Proportion of employed population in civilian labor force	Continuous	US Census Bureau	2000 & 2010

Median household income	Estimated amount which divides the income distribution for households based on people aged > 15 with income	Continuous	US Census Bureau	2000 & 2010
Mean household income	Estimated total aggregate income divided by the number of households based on people aged > 15 with income	Continuous	US Census Bureau	2000 & 2010
Percent population below poverty level	Estimated percent of total population below poverty level for the income year	Continuous	US Census Bureau	2000 & 2010
Urbanization		Dichotomous 1=Urban, 2=Rural	“Underlying cause of death, 1999-2020” from CDC WONDER website	2000-2009 & 2010-2019

Table 2. Descriptive statistics for all county-level variables used in the model

Time Interval	2000-2009			2010-2019		
	(N=105 counties)			(N=115 counties)		
Variables	N	Mean	SD	N	Mean	SD
Outcome variable						
Age-adjusted suicide rates	105	12.94095	2.90416	115	15.33478	3.39688
Predictor Variables						
Percent population White	159	62.37136	16.89902	159	66.22194	17.26656
Percent population Black	159	27.41715	17.36719	159	27.87367	17.48414
Percent population Hispanic	159	6.86601	5.73884	159	5.73816	5.31063
Percent population non-Hispanic	159	93.13399	5.73884	159	94.26184	5.31063
Percent population with high school diploma or higher	159	70.70818	7.54171	159	77.17296	6.79297
Percent population with bachelor's degree or higher	159	13.98302	7.24881	159	15.81950	8.48459
Percent population employed	159	96.63396	1.19835	159	15.81950	1.67596
Median household income	159	34563	93725.60878	159	40203	11327
Mean household income	159	45276	9111	159	52286	12814
Percent population below poverty level	159	86.50943	5.60878	159	84.71195	5.17716
Urbanization	159	1.53459119	0.50037801	159	1.53459119	0.50037801

**Table 3. Social Determinants of Health among Urban and Rural populations using Pearson Correlation, US Census Bureau
2000 & 2019**

Time Interval	2000-2009		2010-2019	
	(N=105 counties)		(N=115 counties)	
County Variables	Pearson Correlation Coefficient	P-Value	Pearson Correlation Coefficient	P-Value
Race/Ethnicity				
Percent population White	0.54796	<.0001	0.61306	<.0001
Percent population Black	-0.45597	<.0001	-0.55491	<.0001
Percent population Hispanic	-0.24595	0.0114	-0.21905	0.0187
Percent population non-Hispanic	0.24595	0.0114	0.21905	0.0187
Education Level				
Percent population with high school diploma or higher	-0.31519	0.0011	-0.14000	0.1356
Percent population with bachelor's degree or higher	-0.38318	<.0001	-0.25254	0.0065
Socioeconomic Status				
Percent population employed	0.25919	0.0076	0.15972	0.0882
Median household income	-0.27024	0.0053	-0.08816	0.3488
Mean household income	-0.34632	0.0003	-0.13656	0.1456
Percent below poverty level	0.05006	0.6120	0.18951	0.0425
Geographic Location				
Urbanization	0.23609	0.0153	0.11027	0.2407

Table 4. Bivariate Linear Regression Analysis Using Social Determinants of Health on Age-Adjusted Suicide Rates per 100,000 for 2000-2009 and 2010-2019

Predictor Variable	Outcome Variable			
	Age-adjusted suicide rate			
	2000-2009 (N=105 counties)		2010-2019 (N=115 counties)	
Variables	Standardized coefficient (β)	P-value	Standardized coefficient (β)	P-value
Race/Ethnicity				
Percent population White	0.08999	<.0001	0.12419	<.0001
Percent population Black	-0.07762	<.0001	-0.11502	<.0001
Percent population Hispanic				
Percent population non-Hispanic	0.13137	0.0114	0.15624	0.0187
Education Level				
Percent population with high school diploma or higher	-0.12691	0.0011	-0.07755	0.1356
Percent population with bachelor's degree or higher	-0.14211	<.0001	-0.09714	0.0065
Socioeconomic Status				
Percent population employed	0.66740	0.0076	0.37916	0.0882
Median household income	-0.00008232	0.0053	-0.00002635	0.3488
Mean household income	-0.00010466	0.0003		
Percent below poverty level			0.14222	0.0425
Geographic Location				
Urbanization	1.37889	0.0153	0.75231	0.2407

Table 5. Multivariate Regression Analysis using Significant County Variables on Age-Adjusted Suicide Rates per 100,000 for 2000-2009 and 2010-2019

Predictor Variable	Outcome Variable			
	Age-adjusted suicide rate			
	2000 (N=105 counties)		2010 (N=115 counties)	
Variables	Standardized coefficient (β)	P-value	Standardized coefficient (β)	P-value
Race/Ethnicity				
Percent population White	0.00062950	0.9964	0.30340	0.2240
Percent population Black	-0.06994	0.6201	0.19595	0.4411
Percent population Hispanic				
Percent population non- Hispanic	0.11022	0.3995	-0.04395	0.8081
Education Level				
Percent population with high school diploma or higher	-0.00018169	0.9982		
Percent population with bachelor's degree or higher	-0.00978	0.9048	-0.06297	0.1445
Socioeconomic Status				
Percent population employed	0.18436	0.6060	-0.20129	0.3090
Median household income	0.00005138	0.6830		
Mean household income	-0.00013705	0.2298		
Percent below poverty level			0.10100	0.2408
Geographic Location				
Urbanization	0.07059	0.9110		

Table 6. Multivariate Regression Analysis Using Social Determinants of Health on Age-Adjusted Suicide Rates per 100,000 for 2000-2009 and 2010-2019 by Geographic Location

Predictor Variable	Outcome Variable							
	Age-adjusted suicide rate							
	Urban				Rural			
Variables	2000-2009 (N=74 counties)		2010-2019 (N=74 counties)		2000-2009 (N=85 counties)		2010-2019 (N=85 counties)	
	Standardized coefficient (β)	P-value	Standardized coefficient (β)	P-value	Standardized coefficient (β)	P-value	Standardized coefficient (β)	P-value
Race/Ethnicity								
Percent population White	-0.11287	0.3614	0.14475	0.6394	1.54171	0.3984	0.88801	0.1400
Percent population Black	-0.13656	0.2730	0.05047	0.8733	1.36964	0.0016	0.77169	0.1998
Percent population Hispanic	0.18875	0.1146	0.04616	0.8339	-0.97220	0.0104	-0.44820	0.2996
Percent population non-Hispanic								
Education Level								
Percent population with high school diploma or higher	-0.17241	0.0545			0.01401	0.9109		
Percent population with bachelor's degree or higher	-0.01329	0.8679	-0.09121	0.1086	0.15492	0.3310	-0.01315	0.8743
Socioeconomic Status								

Percent population employed	-0.18626	0.6219	0.02994	0.9234	0.15492	0.7872	-0.40337	0.1176
Median household income	0.00015853	0.2121			0.00035767	0.1334		
Mean household income	-0.00014995	0.1867			-0.00039086	0.607		
Percent below poverty level			0.05087	0.6608			0.16042	0.2491

Table 7. Collinearity Diagnostics Among Social Determinants of Health on Age-Adjusted Suicide Rates per 100,000 for 2000-2009

Eigenvalue	Condition Index	Proportion of Variation								
		non-			High school diploma or higher	Bachelor's degree or higher	Employed	Median household income	Mean household income	Urbanization
		White	Black	Hispanic						
0.413	4.731	0.000	0.006	0.000	0.000	0.002	0.000	0.000	0.000	0.005
0.247	6.118	0.000	0.001	0.000	0.000	0.041	0.000	0.001	0.000	0.072
0.072	11.361	0.000	0.001	0.000	0.000	0.127	0.000	0.002	0.000	0.368
0.023	20.119	0.004	0.001	0.001	0.001	0.112	0.000	0.035	0.012	0.339
0.003	55.286 [†]	0.019	0.020	0.009	0.225	0.026	0.001	0.020	0.146	0.000
0.002	61.104 [†]	0.017	0.017	0.018	0.036	0.000	0.004	0.104	0.073	0.110
0.001	114.128 [†]	0.003	0.009	0.001	0.729 [*]	0.559 [*]	0.003	0.706 [*]	0.757 [*]	0.000
0.000	204.338 [†]	0.956 [*]	0.935 [*]	0.969 [*]	0.008	0.046	0.001	0.017	0.000	0.001
0.000	624.078 [†]	0.001	0.011	0.002	0.001	0.086	0.991 [*]	0.115	0.010	0.105

Table 8. Collinearity Diagnostics Among Social Determinants of Health on Age-Adjusted Suicide Rates per 100,000 for 2010-2019

Eigenvalue	Condition Index	Proportion of Variation						
		White	Black	non-Hispanic	Bachelor's degree or higher	Employed	Below Poverty	Urbanization
0.363	4.501	0.000	0.002	0.000	0.000	0.000	0.000	0.001
0.216	5.835	0.000	0.001	0.000	0.275	0.000	0.000	0.001
0.066	10.556	0.000	0.000	0.000	0.197	0.000	0.001	0.082
0.002	57.226 [†]	0.013	0.009	0.034	0.166	0.008	0.116	0.640*
0.000	99.881 [†]	0.002	0.000	0.009	0.105	0.051	0.844*	0.002
0.000	276.441 [†]	0.412	0.386	0.398	0.190	0.688*	0.000	0.021
0.000	298.752 [†]	0.573*	0.603*	0.558*	0.067	0.253	0.039	0.001

Figure 1

Age-adjusted suicide rate per 100,000 during 2000-2009 and 2010-2019

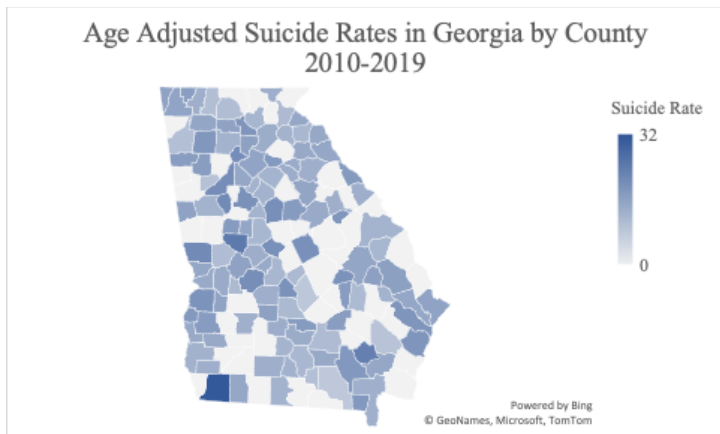
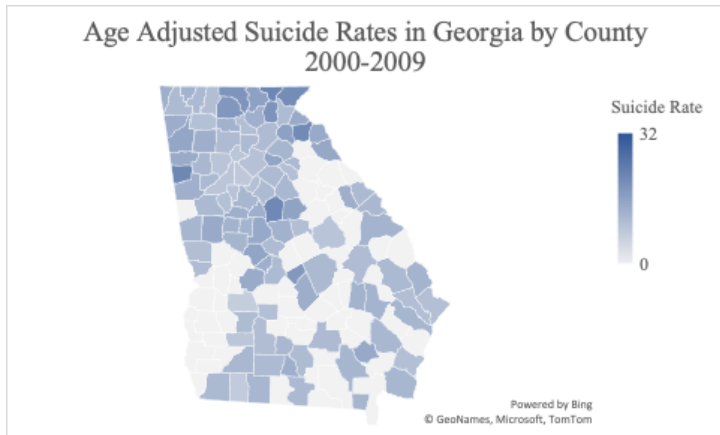


Figure 2. Age-Adjusted Suicide Rates by Public Health Districts, 2000-2009 vs 2010-2019

