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Brief Report

The Relationship Between Per Capita Income, Uninsured Rates, and Cardiovascular Mortality in Georgia Between 1994 – 2016

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ABSTRACT

Background: The association between cardiovascular mortality, per capita income and uninsured rates in Georgia have not been well described.

Methods: Cardiovascular mortality rates, per capita income and uninsured rates were obtained for the years 1994-2016, and their relationships were analyzed using univariate and multivariate statistical techniques.

Results: In bivariate analysis, a strong inverse relationship between cardiovascular mortality and per capita income ($r = -0.917$, $p < 0.0001$) was detected, while bivariate analysis detected no relationship between cardiovascular mortality and uninsured rates. Both per capita income and uninsured rates were negative predictors of cardiovascular mortality in multivariate analysis.

Conclusions: Per capita income increases in Georgia were strongly correlated with reductions in cardiovascular mortality. While there was not a linear correlation of healthcare coverage status and cardiovascular mortality, it demonstrated a protective effect in multivariate analysis.

Keywords: Cardiovascular mortality, uninsured, per capita income
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INTRODUCTION

Multiple studies have demonstrated the inverse relationship between cardiovascular mortality and socioeconomic status (SES) (Conrad, Rehm, Wilde, & Mozaffarian, 2017; Escano-Marin *et al*., 2017). Individuals with lower incomes may experience difficulties accessing health care; however, emerging data suggest that healthcare coverage does not exclusively explain differences in cardiovascular outcomes. In the southeastern US, all-cause (Limdi *et al*., 2016) and cardiovascular *(*Roth *et al*., 2017) mortality rates are higher than in other US regions; therefore, and understanding of which factors influence cardiovascular mortality is key to identifying modifiable risk factors. We examined the relationship between cardiovascular mortality, per capita income, and rates of insurance coverage in the state of Georgia.

METHODS

State-wide cardiovascular mortality rate per 100,000 individuals during calendar years 1994 - 2016 were obtained from the Georgia Online Analytical Statistical Information System (OASIS, Georgia Department of Public Health). Individuals of all ages were included. OASIS lists cause of death as reported on death certificates. Major cardiovascular diseases included were hypertension, rheumatic heart disease, hypertensive heart disease, obstructive heart disease, stroke, atherosclerosis, and aortic aneurysm and dissection. Annual per capita income values for Georgia for the years 1994 - 2016 were obtained from the US Bureau of Economic Analysis (BEA, U.S. Bureau of Economic Analysis). Per capita personal income is defined as the total personal income for each resident of the state divided by the number of residents in the state. Rates of uninsured individuals less than 65 years of age per calendar year were obtained from the United States Census Small Area Health Insurance Estimates Program (SAHIE, U.S. Census Bureau). SAHIE collects data from multiple sources, including the US Census, Medicaid, tax returns, etc to provide an estimated rate of uninsured individuals. Data are reported as mean ± standard deviation. All statistical analyses were performed using Stata® v.14 (StataCorp; College Station, Tx). Pearson's correlations were performed to evaluate the relationship between state-wide cardiovascular mortality per 100,000 and each of the variables per capita income and GA uninsured rates. Multivariate linear regression was then used to model the association between the cardiovascular mortality per 100,000, per capita income, and uninsured rates. Time was not included as a predictor in the regression model. P-values less than 0.05 were indicative of strong evidence against the null hypothesis.

RESULTS

The mean cardiovascular mortality was 257.0 deaths per 100,000 persons and mean per capita personal income was $31,943 per year over the observation period. The mean rate of uninsured individuals was 18.7%. Generally, cardiovascular mortality rates declined during this interval ($p<0.001$); however, between 2013 and 2016, state-wide cardiovascular mortality began to increase (**Figure 1**). There was also an increase in per capita income over the time period examined ($p<0.001$). In contrast to the trends for mortality and per capita income, the uninsured rate remained relatively constant ($p=0.35$, **Figure 1**). There was a significant inverse linear correlation between cardiovascular mortality rates and per capita personal income ($r = -0.917$, $p < 0.0001$, **Figure 2A**). However, there was no correlation between cardiovascular mortality rates and uninsured rates ($r = -0.12$; $p = 0.58$; **Figure 2B**) and no correlation between per capita income and uninsured rates ($r=-0.24$, $p = 0.26$). Despite the observation that there was no linear relationship between uninsured rates and CV death rates, in a multivariate linear regression model, uninsured rates remained a significant negative predictor of CV death rates. Similarly, per capita income was also a significant negative predictor of cardiovascular mortality.

Figure 1: Cardiovascular mortality rates (per 100,000 individuals) for all ages, per capita personal income (USD) and rates of uninsured persons less than 65 years of age (%) for years 1994-2016 in Georgia.

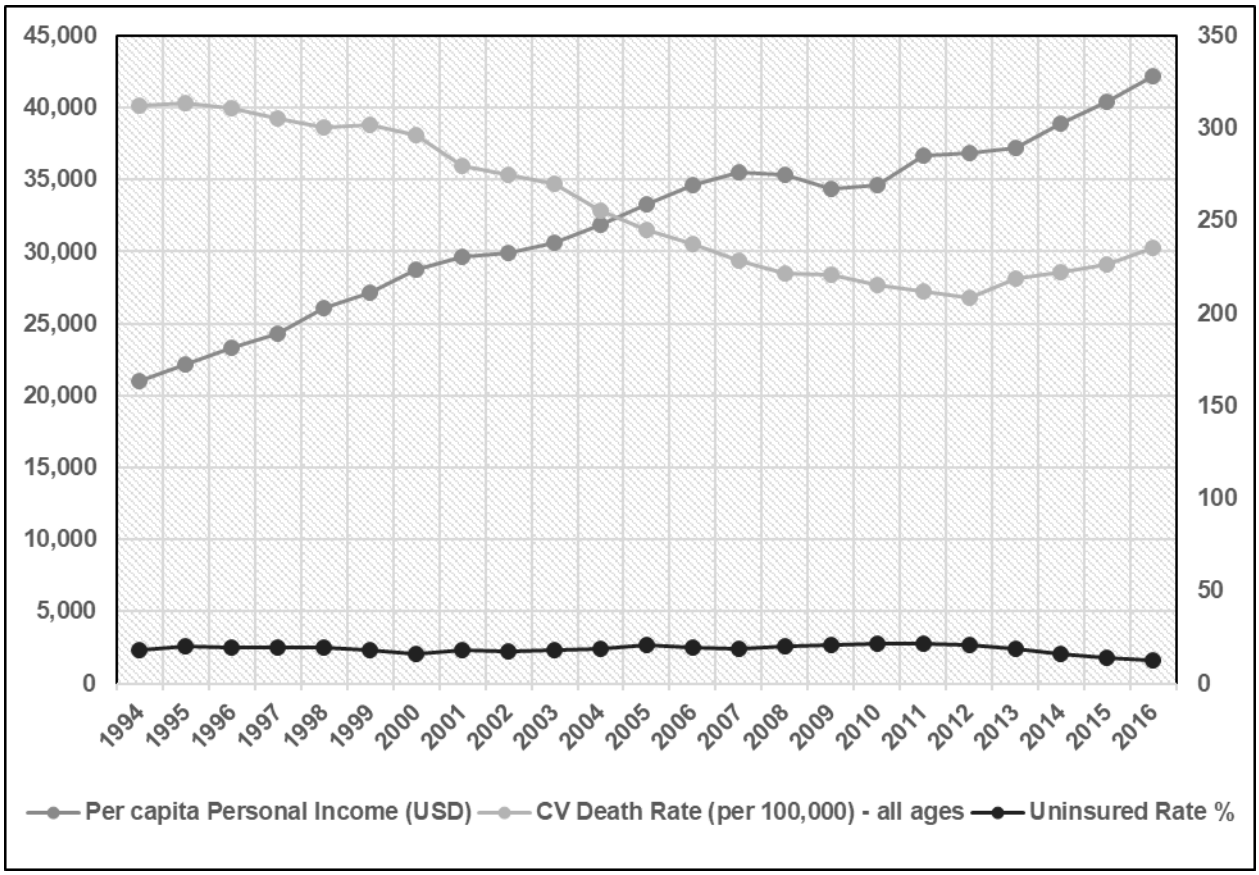

Figure 2: Association of overall cardiovascular mortality in Georgia with: A) per capita personal income (USD), and B) uninsured rates (%).

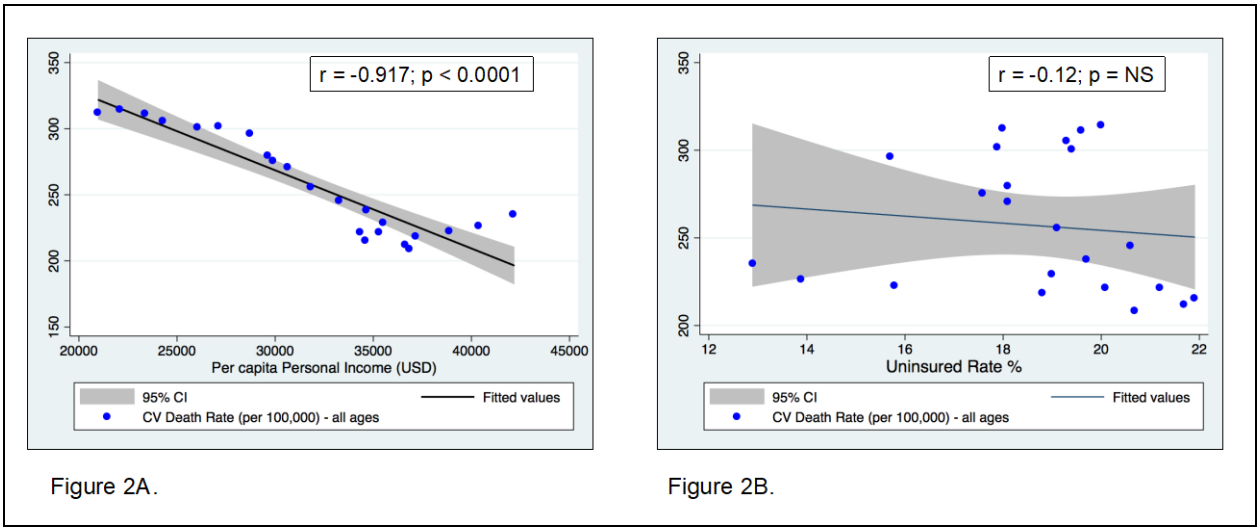

Figure 2A. Figure 2B.

DISCUSSION

Our results illustrate the relationships between state-wide cardiovascular mortality, per capita income, and uninsured rates in Georgia over a 22-year period. Cardiovascular mortality showed an inverse correlation with per capita income, which was not surprising. Rates of uninsured individuals under age 65 did not significantly change over the observed time period. That cardiovascular mortality continued to decline in spite of a stable rate of uninsured individuals was an unexpected finding. This may have special significance, as Georgia declined to expand its Medicaid program in 2014 (Williams, 2014).

The gradual decline in cardiovascular mortality in Georgia mirrored national trends (Limdi *et al*., 2016) over a similar timeframe. Our findings are similar to other studies demonstrating an inverse relationship between income and overall mortality (Jarvandi, Yan, & Schootman, 2012), cardiovascular health (McClurkin *et al*., 2015), and cardiovascular mortality (Jarvandi et al., 2012). Our lack of univariate correlation between insurance rates and cardiovascular mortality is in contrast to a 2012 study by Ng (Ng, Brotman, Lau, & Young, 2012), that found that insurance status drove differences in mortality between blacks and whites who were hospitalized for a major cardiovascular event. However, that study examined patient-level data which was not available here.

In support of our findings, Rask et al demonstrated no significant mortality difference based upon insurance status in a chronic cardiovascular disease population. Their analysis of the effect of behavioral, biological, and socioeconomic factors on overall mortality also found income to be a significant negative predictor of mortality independent of health status (Rask, O'Malley, & Druss, 2009). Additionally, a lack of insurance was associated with a lower mortality risk among healthy respondents [OR 0.43; 95% CI (0.30, 0.62)], compared to healthy respondents with Medicaid or Medicare (Rask *et al*., 2009). The findings in both of these studies suggest that cardiovascular mortality may be more strongly influenced by factors other than access to healthcare. Additionally, these data suggest a role of the concept of "moral hazard", as individuals with healthcare access may be less likely to change risky health behaviors (Simon, Soni, & Cawley, 2017).

We observed cardiovascular mortality during 2013-2016 began to climb after a steady decline. While the reasons for this are unclear, population shifts within Georgia may be contributing to the observed increase in cardiovascular mortality (Granski, Keller, & Venters, 2015; Sadarangani, 2015).

The findings in the study were based on a correlation analysis of aggregate data; therefore, we cannot say with certainty what direct impact per capita income and health insurance status have on an individual's risk of cardiovascular mortality. Causes of death were not adjudicated in this dataset. Additionally, we detected no significant association between cardiovascular mortality and uninsured rates in Georgia. This finding suggests the influence of confounding variables that we were not able to explore with this dataset.

In Georgia, increases in per capita income are associated with lower cardiovascular mortality, while there was not a linear correlation between cardiovascular mortality and uninsured status. As our country grapples with providing healthcare access while protecting healthcare resources, the

relationship between income, access to care and cardiovascular outcomes warrants further investigation at both state and national levels.

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