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State-level educational disparities in mortality in the United States, 2010–2014☆

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ABSTRACT

The present study examined educational disparities in mortality for 49 states and the District of Columbia in the United States based on the 2010–2014 national mortality data. A total of 3,165,762 deaths at ages 25–74 years were included in analysis. Absolute and relative disparities were estimated as Relative Index of Inequality (RII) and Slope Index of Inequality (SII), respectively, based on age-standardized death rates by education, race/ethnicity sex, and state. We found that educational disparities in mortality existed in every US state with varying magnitude across states and by sex. The disparities were generally larger in men than in women on both absolute and relative scales. Across states, for all races combined, the RII varied in the range of 4.2 to 14.9 in men and 3.2 to 10.1 in women; the SII (1/100,000 persons) ranged from 934.0 to 1633.4 in men and from 333.7 to 672.5 in women. Hispanic origin seems to alter the pattern of educational disparities by state. In non-Hispanic whites, some Midwest states had the smallest disparities on both relative and absolute scales. Maryland, Virginia, and Massachusetts had a large relative disparity but a moderate absolute disparity. In general, southern states had a large absolute disparity but a moderate relative disparity. There was a strong correlation (0.66; 95% CI, 0.46–0.79) between educational disparities in mortality and disparities in combined major risk factors (smoking, obesity, and hypertension) by state. These findings call for tailored interventions among socially disadvantaged populations, especially in high disparity states and among young adults.

1. Introduction

Eliminating socioeconomic disparities in mortality has been an overarching goal of public and private health agencies for decades in the United States (Koh, 2010; U.S. Department of Health and Human Services (HHS), n.d.; Freeman, 1989). However, socioeconomic disparities in health have been widening rather than narrowing on a relative scale over the years (Olshansky et al., 2012; Ma et al., 2012; Chetty et al., 2016).

Health policies have the potential to exacerbate or diminish disparities in population health. In the US, most health policies are designed and implemented at the state level, with large variations in the coverage, extension, and strength of these policies (Koller et al., 2016). For example, state cigarette tax rates ranged from 17 cents in Missouri to $4.35 in New York state in 2016 (Campaign for Tobacco-Free Kids, n.d.). As of January 2016, 31 states and the District of Columbia have expanded Medicaid under the Affordable Care Act, while the remaining 19 states have not (U.S. Department of Health and Human Services, n.d.). These differences are expected to result in differential mortalities by socioeconomic status across states. Although an analysis of socioeconomic disparities in morality risk at the state level could shed light on their determinants and inform effective interventions (Mackenbach et al., 2008), to our knowledge, there have been few such studies in the US.

Educational attainment, which affects a person's income and occupation, is a fundamental construct of socioeconomic status (SES). It alters health behaviors and health outcomes through several pathways including access to care, social network, self-control and self-efficacy, cognitive ability, etc. (Lantz et al., 1998; Link and Phelan, 1995; Lleras-Muney, 2005) Herein, we used educational attainment, which is the only socioeconomic variable included in the national mortality files, as a marker of SES to estimate socioeconomic disparities in mortality by race/ethnicity in each state during 2010–2014. In addition, we estimated educational disparities in the prevalence of three major risk factors for the most common causes of death (current smoking, obesity, and hypertension) by state and their correlations with disparities in mortality.

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2. Methods

2.1. Data

Mortality data between 2010 and 2014 were abstracted from the public-use multiple cause of death files published by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC) (Centers for Disease Control and Prevention, n.d.-a). We restricted analysis to deaths that occurred at ages 25–74 years because a person may not have completed education before age 25 and because education information tends to be inaccurate for older age groups (Sorlie and Johnson, 1996). Data for Rhode Island were excluded from analysis because education information was missing on death certificates. Population denominators for mortality calculations were obtained from public-use micro-data sample (PUMS) of the American Community Survey (ACS) published by the US Census Bureau (The United States Census Bureau, n.d.). Behavioral Risk Factor Surveillance System (BRFSS) data (Centers for Disease Control and Prevention, n.d.-b) in 2013 (for hypertension) and 2014 (for current smoking and obesity; no data for hypertension) were used to assess educational disparities in the prevalence of three self-reported risk factors for each state. Current smokers were defined as those who had smoked > 100 cigarettes during their lifetime and smoked at the time of interview. Obesity was defined as having a body mass index (weight in kilograms divided by the square of height in meters) equal to or > 30. Based on the Human Research Protections policy and guidance (Office for Human Research Protections Policy and Guidance. US Department of Health and Human Services, n.d.), this study does not require institutional review board review, because all data are individually de-identified and publicly available.

There are two versions (1989- and 2003-version) of death certificates adopted in the National Vital Statistics System to record education of the deceased. The former records education as number of years of schooling and the latter records education as the highest degree received. During 2010–2014, 6 states used the 1989-version; 32 states and District of Columbia (DC) used the 2003-version, and 11 states transitioned from the 1989-version to 2003-version (Supplemental Table 1). The ACS uses the degree classification system to record the respondent's education, similar to the 2003-version of the death certificate. It has been shown that there are some discrepancies between these two systems in grouping corresponding educational categories (≤ 12 years of education vs. ≤ high school, 13–15 years of education vs. some college, ≥ 16 years of education vs. ≥ bachelor's degree) (Kominski and Adams, 1994). To reduce these inconsistencies in education classification across states, we adjusted the number of deaths for each educational category collected by the 1989-version death certificate. Specifically, we generated adjustment factors for each 1989-version educational group by comparing the educational distributions of deaths in two consecutive years when death certificate transition occurred in those states that have completed the transition. In addition, we adjusted for missing of education information assuming that missing is independent conditional on age, sex, and race. Specifically, we allocated the deaths with missing education by age, sex, and race, based on the known educational distributions in each age-sex-race group. The proportion of deaths with missing education is < 3% in most states (Supplemental Table S1). For convenience, we treat DC as a state.

2.2. Statistical analysis

Age-standardized death rates were calculated for each state according to the 2000 US standard population by educational attainment (high school or below, some college, bachelor's degree or above), sex, and race/ethnicity (non-Hispanic white, non-Hispanic black, and Hispanic). Because the distribution of educational attainment varies substantially across states (Supplemental Table S2), relative and absolute disparities in each state were estimated as Relative Index of Inequality (RII) and Slope Index of Inequality (SII), respectively, using Poisson regression on age-standardized death rates with the cumulative distribution of education categories. The RII and SII represent the estimated mortality differences from the lowest to the highest end of the educational hierarchy. A RII > 1 or SII > 0 indicates that the risk of death is higher in less educated than in more educated individuals. For reliability reasons, we only report the results for those states where all death rates that were included in disparity calculation have a standard error < 20% of the rate (equivalent to > 20 deaths) (Kochanek et al., 2016).

Similarly, SIIs and RIIs were estimated for prevalence of smoking, obesity, and hypertension. In supplemental analyses, we calculated the correlation between educational disparities in mortality (2010–2014) and disparities in prevalence of individual risk factors (current smoking, obesity, and hypertension) by state among non-Hispanic whites using 2003 and 2013/2014 BRFSS data. Correlation between disparities in mortality and the three major risk factors combined was estimated as the correlation of $\ln(RII_{mortality})$ with $[\ln(RII_{smoking}) + \ln(RII_{obesity}) + \ln(RII_{hypertension})]$.

Mortality rate and disparity estimation were performed using SAS 9.4 (SAS Institute Inc., Cary, North Carolina) and prevalence of risk factors was estimated using SAS callable SUDAAN version 11.0 (RTI International, Research Triangle Park, North Carolina).

3. Results

During 2010–2014, death rate (1/100,000 persons) for those at the lowest end of educational hierarchy was 685.2 (95% confidence interval [CI], 680.8–689.5) or 5.2 times (95% CI, 5.1–5.2) higher than that for those at the highest end in the US (Table 1 and Supplemental Table S3). For men and women combined, SIIs (1/100,000 persons) ranged from 485.3 (95% CI, 473.0–497.6) in California to 1230.3 (95% CI, 1083.0–1377.6) in DC, whereas RIIs ranged from 3.2 (95% CI, 3.1–3.4) to 12.4 (95% CI, 9.5–16.3) in these two states.

Larger SIIs and RIIs were found in men than in women nationally and in nearly every state, while the geographic patterns by sex were similar (Figs. 1 and 2). Disparities tended to be lower, especially on a relative scale, in states with a higher proportion of Hispanics, such as Nevada, California, and Florida. Maryland, Virginia, Massachusetts, Michigan, and Ohio are among the states with the highest relative disparities, while Alabama, Kentucky, West Virginia, Mississippi, and Tennessee are among the states with the highest absolute disparities.

Fig. 3 and Supplemental Tables S4-S6 show educational disparities by race/ethnicity and state. In non-Hispanic whites, unlike what was observed for all races combined, states with the smallest disparities were all in the Midwest (Minnesota, South Dakota, and North Dakota) and Midwest had the lowest RII among the four US regions (Supplemental Table S7). Maryland, Virginia, and Massachusetts had a large relative disparity but a moderate absolute disparity while Alabama, West Virginia, and Kentucky had a large absolute disparity but a moderate relative disparity. Supplemental Table S7 shows that the SII in south region (863.3/100,000 persons) was about 20% higher than in other regions. There were no clear geographic patterns of educational disparity in non-Hispanic blacks and Hispanics, although DC showed the highest relative and absolute disparities in non-Hispanic blacks similar to those in non-Hispanic whites.

Fig. 4 depicts educational disparities in prevalence of smoking, obesity, and hypertension by educational attainment for all races combined by sex across states. In every state, higher prevalence was found in less educated people for all the three risk factors studied (Supplemental Tables S8–S10). The disparities appeared to be larger in smoking than in obesity and hypertension. Similar to what were observed in mortality, there were considerable variations in educational disparities in prevalence of risk factors across states. Additional analyses (Supplemental Table S11) showed that the correlation between educational disparities in mortality (2010–2014) and in prevalence of