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RESEARCH ARTICLE

Deaths of Despair(ity) in Early 21st Century America: The Rise of Mortality and Racial/Ethnic Disparities

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Introduction: Recent media coverage and research have emphasized increasing mortality rates for middle-aged white Americans. A concern is that this has shifted focus away from the health burden of other population subgroups. This cross-sectional study compares the magnitude of racial/ethnic mortality disparities across age groups and investigates how changing mortality trends have affected these disparities.

Methods: Mortality data from 2007 to 2016 by race/ethnicity and age were obtained from the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research database in 2018–2019. Absolute and relative racial/ethnic mortality disparities by age groups were determined by calculating between-group variance and mortality rate–adjusted between-group variance, respectively. Trends in disparities were analyzed using joinpoint regression modeling. Annual percentage change in rate-adjusted between-group variance was calculated for each trend segment as well as the relative contribution of each racial/ethnic group to the change.

Results: The largest relative and absolute disparities were found in the youngest and oldest age groups, respectively. Trend analysis detected an inflection point between 2009 and 2012 for most age groups where a period of decreasing disparities changed to one of increasing disparities. Three quarters of the decreasing disparities in Period 1 were resultant of lowering mortality among the black subgroup. During Period 2, the increase in child disparities were due to increased mortality among blacks, whereas increased adult disparities were due to increased mortality among whites shifting the overall mean away from subgroups with lower rates.

Conclusions: Racial/ethnic mortality disparities persist and are widening for some age groups. It is imperative to maintain focus on the age groups where those with historically poorer health are contributing most to the increase.

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INTRODUCTION

Recent media coverage and research have focused on increasing mortality rates for middle-aged white Americans because of suicides and drug/alcohol poisonings. Coined "deaths of despair" in a landmark study, Case and Deaton[1] found the mortality rate for whites aged 45–54 years increased in contrast to a falling rate for blacks and Hispanics in the same age group. Subsequent studies, including a 2017 follow-up by Case and Deaton[2] and Stein et al.,[3] added to these findings by showing that the increase in mortality rates was largely due to increases in mortality among white individuals living outside urban areas and white individuals with a high school diploma or less.

Although this alarming trend deserves the media attention it has garnered and addressing its causes, such as the opioid epidemic, should be of high priority for those responsible for population health, a concern of

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this line of research and the narrative it has evoked is a shifted focus away from the health burden of other racial/ethnic and age-specific population subgroups.[4–6] The U.S. has a history of significant racial/ethnic disparities in mortality rates.[7] For instance, it is noteworthy that, despite the rise in mortality among middle-aged whites, the rates among middle-aged African Americans and American Indians (AIs) remain substantially higher.[8] This pattern plays out in other age groups, as well. Meanwhile, other racial/ethnic minorities, such as Asians and Hispanics, tend to have mortality rates lower than the population mean, leading to wide variation in the mortality rate across population subgroups.

The spread of outcomes, such as the mortality rate across racial/ethnic subgroups discussed here, is as important an indicator of the health of a population to consider as the population mean. Additionally, understanding how these disparities scale to the national context are important for policymakers. That is why it is a goal of *Healthy People 2020* to achieve health equity, eliminate disparities, and improve the health of all groups, in addition to attaining high-quality, longer lives free of preventable disease, disability, injury, and premature death.[9] In regard to racial/ethnic mortality disparities, what is not well described is which age groups are experiencing the largest disparities in mortality and how these gaps have changed alongside the more publicized trends in middle-aged Americans over the last decade. The purpose of this study is to examine premature mortality rates for people aged <1 to 74 years in the U.S. and compare recent trends in disparities by race/ethnicity across age groups, with the goal of signaling where public health might focus interventions to improve mortality rates for all.

METHODS

Study Sample

Data from U.S. death certificates were obtained from the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER) online database provided by the National Center for Health Statistics in 2018–2019.[8] The number of deaths and the population size of subgroups based on age and race/ethnicity were downloaded for the most recent decade of available data, spanning the years 2007–2016. Age groups were categorized as follows: <1, 1–4, 5–14, 15–24, 25–34, 35–44, 45–54, 55–64, and 65–74 years. Deaths of those aged ≥75 years were excluded as the focus of this research was on premature or preventable deaths. Racial/ethnic groups were white, non-Hispanic (white); black, non-Hispanic (black); Asian, non-Hispanic (Asian); AI/Alaska Native (AN), non-Hispanic (AI/AN); and Hispanic (Hispanic). To account for misclassification of AI/AN deaths,[10] mortality rates from the 654 counties considered Purchased/Referred Care Delivery Areas, designated by the Indian Health Service, were applied to the AI/AN population size from CDC WONDER to derive an adjusted number of deaths. Because AI/AN deaths are often misattributed to the white population, the difference between the number of deaths reported by CDC WONDER and the adjusted number of deaths was then subtracted from the death count of the white subgroup, so as to not artificially inflate the overall population mean rate. Those missing data for age or Hispanic origin were not included in the study sample.

Measures

Disparities in mortality rates between the race/ethnicity-by-age subgroups were determined by calculating the between-group variance (BGV), a population-weighted measure of absolute disparity that summarizes the distance of multiple groups from the population average. It is well established that the choice of health disparity metric comes with intrinsic value judgments and methodologic considerations.[11,12] BGV was chosen for the following reasons: (1) it weights each subgroup's deviation from the reference value by population size; (2) it uses the population average rate as the reference; and (3) it succinctly summarizes the disparity across multiple subgroups with a single value. The use of population weighting emphasizes that it is the individuals who make up the subgroups, not the socially constructed subgroups themselves, that are significant. This is important from a population health perspective because interventions to improve the health of each subgroup must consider their respective sizes. The use of the population mean as the reference group in this metric is preferred as it does not unnecessarily stigmatize or idealize individual subgroups, such as when using the best or worst groups' rates as the reference or by using the white rate and advancing the narrative of this group serving as the "normative" group. However, because using the white rate as the reference is a common practice, BGV using this method was calculated and included in supplemental data to demonstrate its effect on the results (Appendix Tables 1 and 2, available online).

The BGV was calculated according to Equation 1. To facilitate the comparison of racial/ethnic disparities across age groups, which have widely different average mortality rates, mortality rate–adjusted BGVs were then calculated according to Equation 2 by dividing the BGV by the mean mortality rate within each age group. Higher mortality rate–adjusted BGV values indicated a greater relative disparity.

$$\mathrm{BGV} = \sum_{j=1}^{J} p_j \left(y_j - \mu\right)^2 \quad (1)$$

j indicates the race/ethnicity group, p_j represents group j's proportion of the total population, y_j represents group j's mortality rate, and μ represents the average mortality rate of the population.[13]

$$\text{Mortality rate–adjusted BGV} = (\mathrm{BGV}_i)/(\mu_i) \quad (2)$$

i indicates each age group.

Statistical Analysis

Joinpoint, or segmented, regression modeling was used to examine how the trends in racial/ethnic mortality disparities changed by age groups between 2007 and 2016. This method allows for characterization of trends over time through the identification of time points, otherwise known as joinpoints or knots, where the trend changed significantly.[14] The joinpoints and the annual

percentage change of the trend line between them were determined based on logarithmically transformed mortality rates and their SEs using the National Cancer Institute's JoinPoint Regression Program, version 4.6.0.0 in 2018–2019.[15]

The relative contribution of each race to the overall change in mortality rate–adjusted BGV was then calculated for age groups that had a statistically significant change over the period of study detected by the joinpoint regression analysis. The relative contribution of each race to the overall change in rate-adjusted BGV for each time period was determined by dividing the change in the race-specific rate-adjusted BGV on the linear scale by the change in the overall rate-adjusted BGV.

RESULTS

Table 1 provides sub-BGV values for each race/ethnicity, as well as the absolute BGV and rate-adjusted BGV for each age group in 2016. Comparing absolute and rate-adjusted BGV values between age groups, the largest racial/ethnic disparities were seen among infants and the oldest age groups. The largest absolute disparities were among the oldest age group, with BGV values >1.8 times that of any other age group. However, after mortality rate adjustment, the relative disparities among infants were >1.7 times that of the other age groups. These results were unchanged in the supplemental analysis (Appendix Table 1, available online). Within age groups, the largest contributions to the absolute BGV tended to be from the black and Asian subpopulations. This can be explained by a combination of mortality rates that were significantly higher, in the case of blacks, and lower, in the case of Asians, than the mean (Appendix Figure 1 available online shows mortality trends by age and race/ethnicity) and their respective population proportions. Black sub-BGV values were often many orders of magnitude higher than the next-closest group—more than 10 times higher in the <1-year age group, for instance. Although the AI/AN population tended to have higher mortality rates than blacks in several age groups, their relatively smaller population resulted in lower sub-BGV values.

Trend analysis of mortality rate–adjusted BGV (Table 2) detected an inflection point for most age groups, roughly halfway through the study period, where a period of decreasing disparities changed to a period of increasing disparities. Because the inflection points were determined independently by age group and the year of the inflection points were similar but distinct (between 2009 and 2012), the periods before and after the inflection point are hereafter referred to as Period 1 and Period 2, respectively, for all age groups. Changes that reached statistical significance were found in children aged <1 year and 1–4 years, and in adults aged 35–44, 45–54, and 55–64 years. More specifically, statistically significant decreases in racial/ethnic mortality disparities during Period 1 came to an end in the groups aged <1 year and 35–64 years, and statistically significant increases in racial/ethnic mortality disparities began for the groups aged 1–4 years and 35–64 years in Period 2. The supplemental analysis (Appendix Table 2, available online) found similar results, with the addition of a significant increase in the group aged 25–34 years in Period 2.

Figure 1A and 1B shows the relative contribution of each race/ethnicity by age group to the change in mortality rate–adjusted BGV for the races/ethnicities who experienced statistically significant changes in disparities. Figure 2A and 2B shows the change in mortality rate for each race/ethnicity over the same periods to provide context for their relative contribution to the change in rate-adjusted BGV. During Period 1 (Figures 1A and 2A), which Table 2 showed to be a time of overall decreasing disparities, the large majority (73% on average across age groups) of the decrease was due to the black subgroup (Figure 1A). This subgroup experienced a reduction in mortality rate in all age groups

Table 1. Racial/Ethnic Mortality Disparities (BGV) by Race/Ethnicity and Age Groups: U.S., 2016

Age group, years	White sub-BGV	Black sub-BGV	Asian sub-BGV	AI/AN sub-BGV	Hispanic sub-BGV	Absolute BGV[a]	Rate-adjusted BGV[b]
<1	4,811	45,876	1,647	1,471	3,048	56,853	98
1–4	1	40	4	14	9	69	3
5–14	0	7	1	2	1	11	1
15–24	4	250	84	78	50	467	6
25–34	36	419	559	431	295	1,740	14
35–44	93	1,186	1,025	864	916	4,084	21
45–54	130	4,300	3,434	1,671	2,975	12,510	31
55–64	3	21,556	11,389	1,798	7,404	42,150	48
65–74	179	44,174	37,100	2,634	18,323	102,410	57

[a]Absolute BGV units = deaths^2/population^2.
[b]Rate-adjusted BGV is adjusted by the age group–specific mortality rate and units = deaths/population.
AI/AN, American Indian/Alaska Native; BGV, between-group variance.

Table 2. Joinpoint Trend Analysis of Racial/Ethnic Mortality Rate-Adjusted BGV by Age Group: U.S., 2007–2016

Age group, years	Lower endpoint	Upper endpoint	Annual change in rate-adjusted BGV	Annual % change in rate-adjusted BGV (95% CI)[a]
Period 1				
<1	2007	2012	**–6.88**	**–6.5 (–11.1, –1.6)**
1–4	2007	2009	–0.23	–9.9 (–31.3, 18.2)
5–14	2007	2016	0.01	1.2 (–2.8, 5.3)
15–24	2007	2016	0.09	1.8 (–0.3, 4.0)
25–34	2007	2010	–0.61	–4.8 (–12.0, 2.9)
35–44	2007	2010	**–0.85**	**–4.4 (–8.0, –0.7)**
45–54	2007	2011	**–1.89**	**–6.2 (–8.5, –4.0)**
55–64	2007	2011	**–1.28**	**–2.7 (–5.2, –0.2)**
65–74	2007	2016	0.10	0.2 (–0.6, 1.0)
Period 2				
<1	2012	2016	2.78	2.9 (–4.2, 10.5)
1–4	2009	2016	**0.17**	**7.3 (3.5, 11.3)**
5–14	—	—	—	—
15–24	—	—	—	—
25–34	2010	2016	0.31	2.6 (–0.1, 5.3)
35–44	2010	2016	**0.64**	**3.4 (2.0, 4.7)**
45–54	2011	2016	**1.09**	**3.9 (2.1, 5.6)**
55–64	2011	2016	**0.94**	**2.1 (0.2, 4.0)**
65–74	—	—	—	—

Note: Periods refer to before and after an inflection point in the overall trend, detected by joinpoint regression analysis. Boldface indicates statistical significance of trend different from 0 at $p<0.05$.
[a]Determined by log transformation of rate-adjusted BGV.
BGV, between-group variance.

(Figure 2A), reducing their distance from the mean mortality rate (Appendix Figure 1, available online, shows mortality trends by age and race/ethnicity). During Period 2, where Table 2 showed that disparities began to increase, the relative racial/ethnic contribution to the change depended on the age group (Figure 1B). For the groups aged <1 year and 1–4 years, approximately half (52%) of change came again from the black subgroup, where small increases in the black mortality rate, and decreases in mortality rates below the mean for certain racial/ethnic groups, increased the distance of the black subgroup's mortality rate from the mean mortality rate (Figure 2B). For the adults aged 35–64 years, the largest contributions came from Hispanics and Asians (61% combined). These subgroups, whose rates were already below the mean mortality rate, further diverged from the mean as the mortality rates among whites, the population with the greatest number of deaths, and AI/ANs substantially increased.

DISCUSSION

This study has several major findings. The first, which came from the comparison of racial/ethnic mortality disparities between age groups, was that disparities were largest in infants and the oldest age group (65–74 years), depending on the BGV method used. BGV values, both adjusted and absolute, were significantly smaller in the middle age groups (25–54 years). This lends support to the notion that the emphasis on the rising mortality rates among middle-aged whites could be obscuring age groups where people of color are experiencing much worse health. In 2016, mortality rates among black and AI/AN subgroups remained higher than rates among whites in every age group (Appendix Figure 1, available online); in the youngest age group, the rate for blacks was more than twice as high.

The second major finding is that, over the course of the past decade, the U.S. has either ceased or reversed years of progress in reducing racial/ethnic disparities in mortality across most age groups. To the best of the authors' knowledge, this is the first study to characterize 2 distinct periods of change in racial/ethnic mortality disparities from all causes in the U.S. during this timeframe. This was made possible using joinpoint regression techniques versus the more traditional linear methodology, which ignores year-to-year fluctuations in the data. The stalled progress in reducing racial/ethnic mortality disparities in Period 2 is a major cause for concern for the health of the population.

As demonstrated in Figures 1 and 2, the story of which racial/ethnic groups contributed most to this

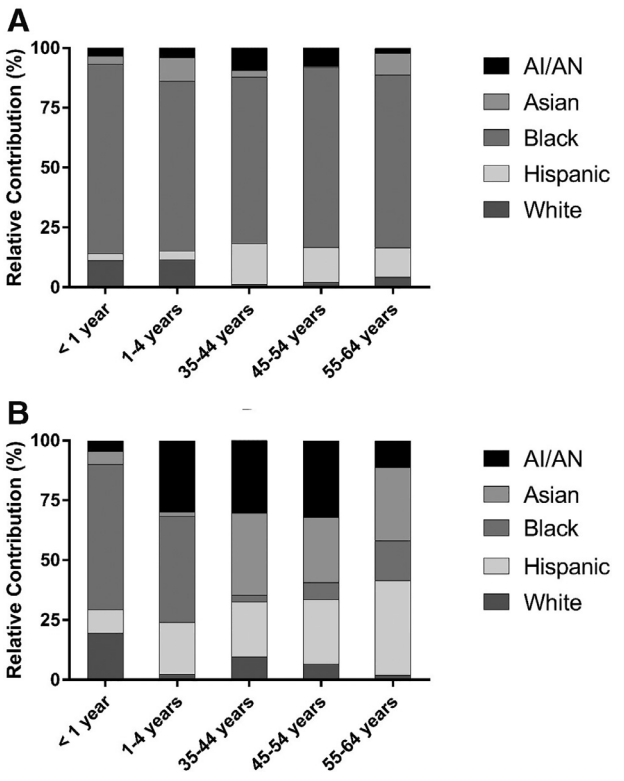

Figure 1. Racial/ethnic relative contribution to the change in rate-adjusted BGV where the change was statistically significant: U.S., 2007–2016. (A) refers to Period 1 and (B) refers to Period 2. Periods refer to before and after an inflection point in the overall trend, detected by joinpoint regression analysis. Inflection points were determined independently by age group but fell between 2009 and 2012 for those age groups where one was detected (Table 2).
AI/AN, American Indian/Alaska Native; BGV, between-group variance.

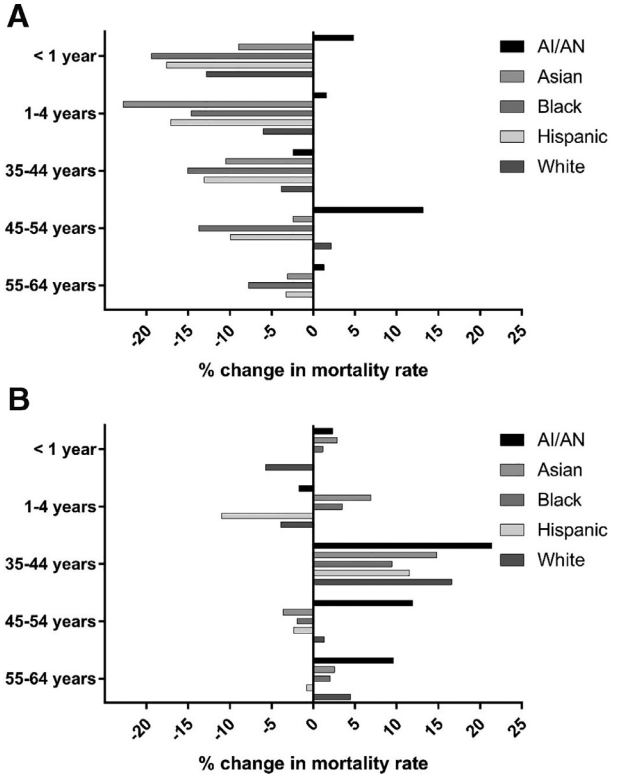

Figure 2. Mortality rate change by period where the change in rate-adjusted BGV was statistically significant: U.S., 2007–2016. (A) refers to Period 1 and (B) refers to Period 2. Periods refer to before and after an inflection point in the overall trend, detected by joinpoint regression analysis. Inflection points were determined independently by age group but fell between 2009 and 2012 for those age groups where one was detected (Table 2).
AI/AN, American Indian/Alaska Native; BGV, between-group variance.

increase in mortality disparities in Period 2 is complex and differed by age group. The findings reveal that in the younger age groups, the halting of progress in reducing black child mortality was profoundly impactful on the increase of racial/ethnic disparities. Mortality rates for injury deaths among black infants rose much faster than other racial/ethnic groups during the same 10-year period,[8] of which the leading causes were unintentional suffocation and strangulation in bed, consistent with the findings of other studies.[16] For adults aged 35–64 years in Period 2, Hispanic and Asian subgroups were shown to be the biggest drivers of the increased disparities, though this is likely an indirect outcome of the increase in the white subgroup mortality rate during this period. Because the white subgroup makes up such a large proportion of the study population (61% in 2016), its mortality rate heavily influences the mean (overall) mortality rate and, thus, the increased mortality among whites likely pulled the overall mean mortality rate up and away from the Hispanic and Asian subgroups and toward the black and AI/AN subgroups. The increase in white mortality in the groups aged 35–64 years over this time period relative to the other races/ethnicities could be a reflection of increased "deaths of despair," as observed by Case and Deaton,[1,2] and the leveling off or reversal of progress in reducing deaths because of the most common causes.[17] To wit, although alcohol- and drug-induced death rates increased across all racial/ethnic groups of those aged 35–64 years, the magnitude of the increase among the white subgroup was between 1.7 and 10 times higher than the other subgroups.[8] Meanwhile, reductions in mortality because of heart disease for the white subgroup were the smallest among the racial/ethnic groups, apart from the AI/AN subgroup.

Taken together, these findings suggest, again, that mortality trends among whites are important and influential to the overall mortality rate and racial/ethnic disparities, but they are not the whole story. This is especially so in the younger age groups where increasing

disparities are being driven by worsening mortality rates among racial/ethnic groups that historically and presently face societal barriers to good health. Although the root causes of these disparities are multitudinous and intertwined, upstream factors, such as discriminatory policies, institutions, and practices, have limited the opportunities of certain population subgroups—whether by race/ethnicity, class, or other—leading to differences in socioeconomic conditions that have profound impacts on health.[18] These results highlight the need for solutions that are tailored to specific age and racial/ethnic groups if the U.S. hopes to effectively address the recent trend of increasing disparities.

This study draws both strengths and limitations from the use of methods like BGV and joinpoint regression to quantify health disparities and track them over time. BGV is one of dozens of measures of health disparities, each with their own set of considerations and the potential for disparate results. As previously discussed, BGV was chosen because its measurement properties align with the authors' values and understanding of health inequities. Other more practical considerations for this choice were that BGV is relatively easy to calculate and to communicate to stakeholders, policymakers, and the public. The ease of communication is a function of BGV summarizing disparities between more than 2 subgroups—5 racial/ethnic groups, in this case—with a single value. This is a potential strength for translational research platforms and data repositories intended to support stakeholders—some more data fluent than others—such as public health practitioners, policymakers, journalists, and community organizations, in catalyzing action toward improved health and equity.

Limitations

However, there are also several important considerations regarding the use of BGV as a measure of health disparities. First, BGV only accounts for the variance between racial/ethnic groups, and thus does not provide insight into the effect of within-group variation on overall population health. Second, because total BGV is a function of each group's mean and total population size, troubling mortality trends among small subgroups, such as AI/ANs, may be downplayed via a small contribution to the total BGV, but they should not be ignored. Third, a proper explanation of the change in BGV requires the examination of trends in the underlying data, as demonstrated. This is because, hypothetically, a decrease in BGV can indicate all subgroups are worsening toward a common point, bettering toward a common point, or some combination of both, and because changing demography can influence the change in BGV. For these reasons, the authors recommend making the data available for the underlying metric (e.g., mortality rates in this study) when presenting the results of BGV, particularly when analyzing trends.

CONCLUSIONS

This study reinforces a strong body of prior research describing pervasive racial/ethnic disparities in mortality in the U.S. These findings call attention to the urgency in addressing recent shifts in racial mortality disparities, particularly among the youngest age group where increasing disparity is resultant from a reversal of progress in a large, marginalized population subgroup. Although beyond the scope of this paper, future research efforts can help improve understanding of what may be underlying these mortality shifts. For example, further exploration of trends in leading causes of death among age groups and the overall trajectory of length of life among racial/ethnic groups can inform more targeted public health interventions. Fundamental lessons learned from previous periods with observed progress in mortality would suggest that investments in social and economic community conditions that create opportunities for all population groups is key to realizing progress once more in mortality disparities and for improving the health of the nation.[18,19]

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SUPPLEMENTAL MATERIAL

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