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State-Level Trends in Lifespan Variability in the United States, 1960–2019: A Research Note

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ABSTRACT State-level disparities in life expectancy are wide, persistent, and potentially growing in the United States. However, the extent to which differences in lifespan variability by state have changed over time is unclear. This research note describes trends in lifespan variability for the United States overall and by state from 1960 to 2019 using period life table data from the United States Mortality Database. Lifespan disparity at birth ($e_0^\dagger$) decreased over time in the United States overall from 14.0 years in 1960–1964 to 12.2 in 2015–2019. Lifespan variability decreased in all states, but states differed in the level and pace with which these changes occurred. Southern states and the District of Columbia exhibited consistently higher (i.e., less equitable) levels of lifespan variability than the nation overall. Conversely, lifespan variability was lower among several states in the Northeast (e.g., Connecticut and Massachusetts), Upper Midwest (e.g., Iowa, Minnesota, and Wisconsin), and West (e.g., California, Oregon, Utah, and Washington). We observe a particularly worrisome trend of *increasing* lifespan variability for the United States overall and for most states from 2010–2014 to 2015–2019. Monitoring state-level trends in lifespan variability has the potential to inform policies designed to ameliorate population health disparities.

KEYWORDS Mortality • States • Lifespan variability • United States

Introduction

Where a person lives has important consequences for their health and well-being. In the United States, geographic areas vary on several social, economic, and political dimensions that are associated with mortality risk (Ezzati et al. 2008; Hummer and Hamilton 2019). States are of particular interest because they are semiautonomous units whose governments exert considerable influence over the implementation of policies regarding social service programs and healthcare delivery (Montez et al. 2020). Compositional and contextual differences by state contribute to geographic disparities in mortality risk in the United States that are wide, persistent, and potentially growing (James et al. 2018; Montez et al. 2019). For example, in 2019, life expectancy ranged from a high of 80.9 years in Hawaii to a low of 74.4 years in

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Mississippi (Arias et al. 2022). This wide range among U.S. states exceeds the range in life expectancy among high-income nations (Wilmoth et al. 2011).

Life expectancy is often used to compare mortality levels *between* populations. It expresses the average number of additional years members of a hypothetical cohort can expect to live under prevailing mortality conditions. Life expectancy at birth—the first moment of the age-at-death distribution—also represents the mean age at death in a life table. Lifespan variability—the second moment of the distribution—measures dispersion in lifespans around the mean and summarizes *within*-population disparities. Populations with comparable life expectancies may differ substantially in their age-at-death distributions (Smits and Monden 2009; Wilmoth and Horiuchi 1999). Higher lifespan variability reflects greater interindividual inequality and uncertainty about age at death (Edwards and Tuljapurkar 2005; Engelman et al. 2010). This uncertainty presents challenges for individuals and institutions to allocate resources for social service programs and later-life health costs (Edwards 2013; van Raalte et al. 2018). Increases in life expectancy have historically coincided with compression of the age-at-death distribution. However, since the second half of the twentieth century, rising life expectancy has not necessarily been accompanied by reductions in variability in individual lifespans in the United States and other high-income countries (Gillespie et al. 2014; Wilmoth and Horiuchi 1999).

International comparisons show that the United States exhibits higher lifespan variability relative to other high-income nations (Edwards and Tuljapurkar 2005; Rogers et al. 2020; Vaupel et al. 2011). This pattern is consistent with other research showing worse health and mortality outcomes in the United States than in peer nations (Crimmins et al. 2010). However, estimates for the United States overall obscure considerable state-level inequalities in mortality. States differ with respect to demographic, cultural, socioeconomic, and other characteristics that are key determinants of lifespan variability (Aburto et al. 2021; Brown et al. 2012; Edwards and Tuljapurkar 2005; Lariscy et al. 2016; Sasson 2016). Moreover, the impact of state-level policy climates on state-level health disparities has likely grown in recent decades as states have increasingly gained political authority previously held at the federal level (via devolution) or local level (via preemption) (Montez et al. 2020). Despite ample evidence that mortality rates and life expectancy vary within countries, few studies have compared subnational trends in lifespan variability (for exceptions in Europe, see Seaman et al. (2019) and Wilson et al. (2020)). This research note addresses this gap by describing trends in lifespan variability for the United States overall and by state between 1960 and 2019.

Methods

Data

We analyze period life table data from the United States Mortality Database (USMDB; 2022), which contains life tables for all 50 U.S. states and the District of Columbia

(D.C.)[1] from 1959 to 2019. We utilize life tables for women, men, and the total population by single year of age for five-year periods from 1960–1964 to 2015–2019. Additional information about the USMDB is available at usa.mortality.org.

Measures

We measure lifespan variability via lifespan disparity at birth ($e_0^\dagger$). This indicator expresses the average remaining life expectancy at a given age of death, or alternatively the average number of years lost to death (Vaupel et al. 2011). Higher values of lifespan disparity represent greater within-population inequality in the age-at-death distribution (i.e., the life table $d(x)$ function). The formula for $e_0^\dagger$ is

$$e_0^\dagger = \frac{\int_0^\omega d(x)e(x)dx}{l(0)},$$

where $d(x)$ is the number of life table deaths at age x, ω is the open age interval (110+), $e(x)$ is remaining life expectancy at age x, and $l(0)$ is the number of survivors at birth (i.e., the life table radix; 100,000). Several other measures are used to analyze variability in the life table age-at-death distribution (e.g., standard deviation, Gini coefficient, interquartile range, Keyfitz's H, and Theil's index). Prior research comparing lifespan variability measures, including $e_0^\dagger$, shows that they are highly correlated (van Raalte and Caswell 2013; Wilmoth and Horiuchi 1999). Moreover, $e_0^\dagger$ is well-suited for assessing the influence of premature mortality because it assigns more weight to deaths that occur below life expectancy and less weight to deaths above life expectancy.

Analytic Approach

We first describe trends in lifespan disparity for the United States overall before examining state-specific trends. For this analytic step, we graph $e_0^\dagger$ values at the national level for each five-year period between 1960–1964 and 2015–2019 for the total population and by sex.[2] After describing national trends in lifespan variability, we then examine state-level trends in lifespan variability in three ways. First, we present trends in $e_0^\dagger$ in five-year periods between 1960–1964 and 2015–2019 for each state and D.C. relative to the United States overall. Second, we plot changes in lifespan variability and changes in life expectancy in three time periods to examine how they covary. Finally, we map lifespan variability by state in 1960–1964 and 2015–2019 to determine whether high-variability and low-variability states tend to cluster together within regions.

[1] Our analyses include D.C. because its population and deaths contribute to the calculation of $e_0^\dagger$ for the United States overall. However, D.C. is a federal district and as such is more akin to a large, densely populated city than a state.

[2] An online supplement contains results from regression models predicting lifespan disparity ($e_0^\dagger$) as a function of time (i.e., over five-year periods) and within state-level fixed effects. The online supplement has additional information about these analyses.

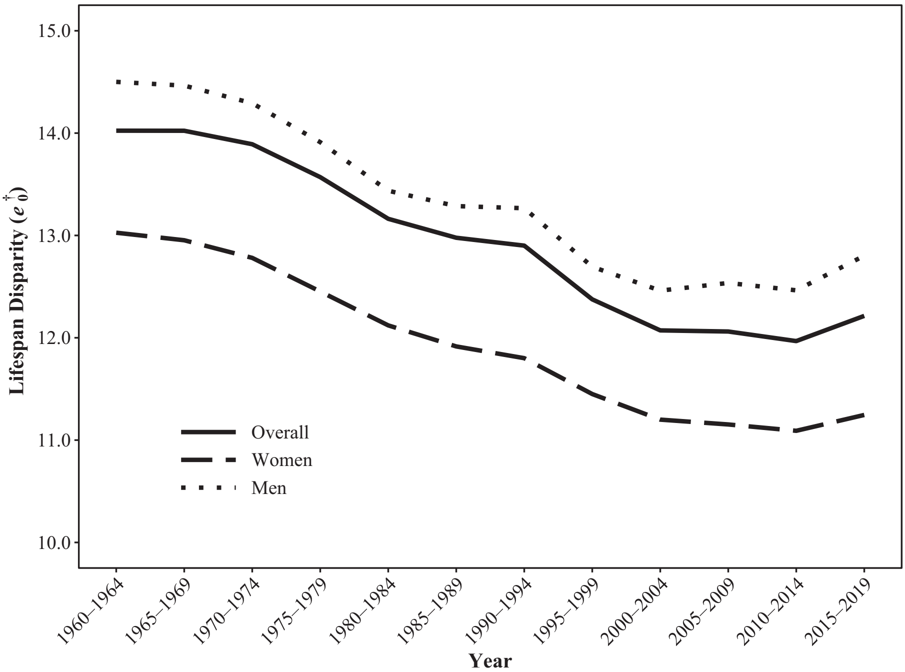

Fig. 1 Overall and sex-specific trends in lifespan disparity at birth ($e_0^\dagger$) in the United States, 1960–2019

Results

Lifespan Variability Trends in the United States

Figure 1 displays trends in $e_0^\dagger$ for the United States overall. Lifespan variability in the United States fell by nearly two years between 1960–1964 (14.0) and 2015–2019 (12.2). However, the pace of these changes fluctuated over time. Lifespan variability was high and stagnant throughout the 1960s (14.0) but declined gradually between 1970–1974 (13.9) and 1980–1984 (13.2). It stagnated again between 1985–1989 (13.0) and 1990–1994 (12.9), fell between 1990–1994 (12.9) and 2000–2004 (12.1), and remained relatively stable until 2010–2014. Lifespan variability *increased* from 2010–2014 to 2015–2019, a reversal of the compression observed in the preceding decades. Levels of lifespan disparity differed noticeably between men and women; $e_0^\dagger$ was consistently about 1.4 years higher among men than women over time (see online supplement Tables S1 and S2 for sex-specific results).

State-Level Trends in Lifespan Variability

Table 1 shows $e_0^\dagger$ values in each five-year period from 1960–1964 to 2015–2019 for each state, D.C., and the United States overall. Figure 2 plots trends in lifespan disparity in each state and D.C. relative to all other states and the United States overall. Each panel in the figure shows trends in lifespan variability for an individual state (black circles) relative to all other states (gray circles) and the national average (diamonds) across five-year periods.

Every state experienced a reduction in lifespan variability between 1960–1964 and 2015–2019, but substantial geographic heterogeneity exists over time by state (Figure 2).[3] Lifespan variability was consistently higher than the national average in southern states, such as Alabama, Louisiana, and Mississippi. For example, lifespan variability was highest in Mississippi in both 1960–1964 ($e_0^\dagger = 16.1$) and 2015–2019 ($e_0^\dagger = 13.7$). D.C. exhibited the highest levels of lifespan variability in several intermediate periods, rising and then falling during the late 1980s and early 1990s. Conversely, lifespan variability was consistently lower in northeastern (e.g., Connecticut and Massachusetts), upper midwestern (e.g., Iowa, Minnesota, and Wisconsin), and western (e.g., California, Oregon, Utah, and Washington) states. Minnesota and Utah, where the average $e_0^\dagger$ over time was nearly one year lower than the U.S. average, consistently had the lowest levels of lifespan variability of all states.

Comparing trends in $e_0^\dagger$ between Minnesota and Mississippi illustrates the substantial amount of interstate mortality inequality that exists within the United States. The gap in lifespan disparity between these states was highest in 1960–1964 (3.0 years), fell to its lowest level in 1985–1989 (1.8 years), and increased thereafter until 2015–2019 (2.5 years). Except for D.C. (whose $e_0^\dagger$ rose sharply and then fell in the 1980s and 1990s), the spread between the highest and lowest $e_0^\dagger$ values widened in recent decades. Indeed, the worst-performing state in 2015–2019 (Mississippi, $e_0^\dagger = 13.7$ years) had higher levels of lifespan variability than the best-performing state almost six decades earlier in 1960–1964 (Minnesota, $e_0^\dagger = 13.1$ years).

Figure 3 plots changes in lifespan variability and changes in life expectancy in three periods to examine how they covary. In the earliest period (1960–1964 to 1975–1979), lifespan variability decreases as life expectancy increases. This negative association was also observed between 1980–1984 and 1995–1999 for all states but not D.C., although the gains in life expectancy were lower than between 1960–1964 and 1975–1979. From 2000–2004 to 2015–2019, changes in $e_0^\dagger$ were positive for 40 states, despite continued life expectancy improvements in every state except West Virginia. Thus, the strong negative association observed between lifespan variability and life expectancy across U.S. states from 1960 to 1999 was reversed for four fifths of states after the year 2000.

Finally, Figure 4 displays maps of lifespan variability in the periods spanning 1960–1964 and 2015–2019 to visualize whether states cluster into high-variability and low-variability regions. Darker shades represent higher (i.e., less equitable) levels of lifespan variability. Several states with high lifespan variability throughout the six-decade period are concentrated in the southern United States, particularly Alabama, Louisiana, Mississippi, and South Carolina. Many states in the Ohio River

[3] We provide model coefficients from linear models incorporating within-state fixed effects in Tables S3–S6 of the online supplement.

Table 1 Lifespan disparity at birth ($e_0^\dagger$) in the United States from 1960–1964 to 2015–2019, by state

State	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	1985–1989	1990–1994	1995–1999	2000–2004	2005–2009	2010–2014	2015–2019
United States	14.0	14.0	13.9	13.6	13.2	13.0	12.9	12.4	12.1	12.1	11.9	12.2
Alabama	15.4	15.3	14.9	14.4	13.8	13.5	13.6	13.3	13.0	13.1	13.1	13.4
Alaska	15.8	15.6	15.1	15.0	14.0	13.4	13.1	12.6	12.5	12.3	12.2	12.9
Arizona	15.3	14.9	14.6	14.2	13.4	13.3	13.0	12.5	12.3	12.1	12.0	12.4
Arkansas	14.6	14.5	14.2	13.8	13.4	13.3	13.4	13.0	12.9	13.0	12.9	13.3
California	13.9	13.9	13.7	13.5	13.0	12.8	12.8	12.1	11.6	11.5	11.3	11.5
Colorado	14.1	13.8	13.6	13.2	12.7	12.4	12.4	11.9	11.6	11.5	11.4	11.6
Connecticut	13.2	13.3	13.1	12.9	12.6	12.5	12.4	11.9	11.6	11.4	11.2	11.5
Delaware	13.9	14.1	13.7	13.5	13.3	13.1	12.8	12.5	12.4	12.3	12.3	12.6
District of Columbia	15.9	16.1	16.4	15.9	15.4	16.1	17.1	15.8	14.5	14.3	13.2	13.7
Florida	15.1	14.9	14.8	14.0	13.6	13.4	13.2	12.6	12.3	12.4	12.1	12.6
Georgia	15.4	15.2	15.0	14.4	13.9	13.6	13.5	12.9	12.6	12.5	12.3	12.6
Hawaii	13.5	13.4	13.2	12.9	12.6	12.4	12.3	12.1	11.8	11.7	11.8	12.1
Idaho	13.9	13.8	13.8	13.4	12.8	12.5	12.2	12.0	11.7	11.7	11.5	11.5
Illinois	13.9	14.1	13.9	13.6	13.2	13.0	13.0	12.5	12.1	11.9	11.8	12.1
Indiana	13.6	13.7	13.6	13.3	12.9	12.8	12.6	12.3	12.2	12.3	12.4	12.7
Iowa	13.2	13.2	13.2	12.9	12.5	12.3	12.1	11.8	11.5	11.5	11.5	11.8
Kansas	13.4	13.4	13.4	13.1	12.8	12.6	12.5	12.2	12.0	12.1	12.0	12.2
Kentucky	14.3	14.1	13.9	13.6	13.3	13.0	12.9	12.5	12.5	12.6	12.8	13.2
Louisiana	15.1	15.1	14.8	14.4	13.9	13.6	13.8	13.4	13.2	13.3	13.0	13.4
Maine	13.7	13.6	13.5	13.2	12.7	12.4	12.2	11.7	11.6	11.7	11.7	12.0
Maryland	14.2	14.1	13.8	13.6	13.2	13.1	13.1	12.7	12.4	12.2	11.9	12.4
Massachusetts	13.2	13.3	13.2	12.9	12.6	12.3	12.2	11.6	11.3	11.2	11.1	11.4
Michigan	13.6	13.8	13.8	13.5	13.1	13.0	12.9	12.4	12.2	12.2	12.2	12.4
Minnesota	13.1	13.2	13.1	12.8	12.4	12.1	11.9	11.5	11.2	11.1	11.1	11.2
Mississippi	16.1	16.0	15.4	14.7	14.2	13.9	14.0	13.7	13.4	13.5	13.4	13.7

Table 1 (continued)

State	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	1985–1989	1990–1994	1995–1999	2000–2004	2005–2009	2010–2014	2015–2019
Missouri	13.9	13.9	13.7	13.5	13.1	12.9	13.0	12.5	12.3	12.4	12.4	12.9
Montana	14.4	14.3	14.3	13.7	13.3	12.9	12.7	12.3	12.1	12.2	12.1	12.3
Nebraska	13.3	13.4	13.3	13.1	12.7	12.4	12.3	11.9	11.7	11.6	11.5	11.7
Nevada	15.3	14.9	14.8	14.2	13.8	13.3	13.2	12.8	12.3	12.2	12.0	12.3
New Hampshire	13.6	13.4	13.3	12.9	12.6	12.3	11.9	11.5	11.3	11.2	11.3	11.7
New Jersey	13.6	13.6	13.4	13.1	12.8	12.8	12.8	12.1	11.6	11.5	11.3	11.6
New Mexico	15.0	14.9	15.0	14.5	13.6	13.4	13.1	12.6	12.5	12.6	12.6	13.3
New York	13.7	13.7	13.7	13.4	13.1	13.3	13.2	12.3	11.7	11.5	11.3	11.5
North Carolina	15.0	14.9	14.8	14.3	13.7	13.4	13.3	12.8	12.5	12.4	12.2	12.5
North Dakota	13.5	13.4	13.2	13.1	12.5	12.2	12.1	11.8	11.7	11.8	11.9	12.2
Ohio	13.5	13.6	13.5	13.3	13.0	12.7	12.6	12.2	12.0	12.2	12.3	12.8
Oklahoma	14.0	13.9	13.9	13.7	13.4	12.9	13.1	12.8	12.6	12.8	13.0	13.2
Oregon	13.6	13.8	13.6	13.3	12.9	12.7	12.4	12.0	11.7	11.7	11.6	11.6
Pennsylvania	13.5	13.5	13.5	13.2	12.8	12.7	12.6	12.2	12.0	12.0	12.0	12.4
Rhode Island	13.2	13.1	13.2	13.0	12.6	12.4	12.3	11.8	11.6	11.5	11.5	11.7
South Carolina	15.9	15.6	15.4	14.7	14.1	13.8	13.7	13.2	13.0	13.0	12.7	13.1
South Dakota	14.0	13.8	13.9	13.7	13.2	12.9	12.7	12.5	12.3	12.1	12.2	12.5
Tennessee	14.4	14.3	14.2	13.8	13.5	13.2	13.2	12.9	12.8	12.9	12.8	13.1
Texas	14.4	14.3	14.2	13.8	13.4	13.1	13.0	12.4	12.1	12.0	11.9	12.1
Utah	13.3	13.1	13.0	12.7	12.3	11.9	11.8	11.5	11.2	11.2	11.2	11.3
Vermont	13.6	13.6	13.3	13.0	12.8	12.4	12.1	11.7	11.4	11.4	11.2	11.5
Virginia	14.5	14.3	14.1	13.7	13.2	12.9	12.7	12.2	11.9	11.8	11.6	11.9
Washington	13.5	13.6	13.6	13.3	12.8	12.6	12.3	11.8	11.6	11.5	11.3	11.4
West Virginia	14.1	14.2	14.1	13.7	13.2	13.0	12.8	12.5	12.5	12.8	13.0	13.6
Wisconsin	13.2	13.2	13.0	12.8	12.5	12.2	12.1	11.8	11.6	11.6	11.5	11.7
Wyoming	14.6	14.1	14.3	14.0	13.1	12.6	12.7	12.3	12.2	12.4	12.3	12.4

Source: United States Mortality Database, 1960–2019.

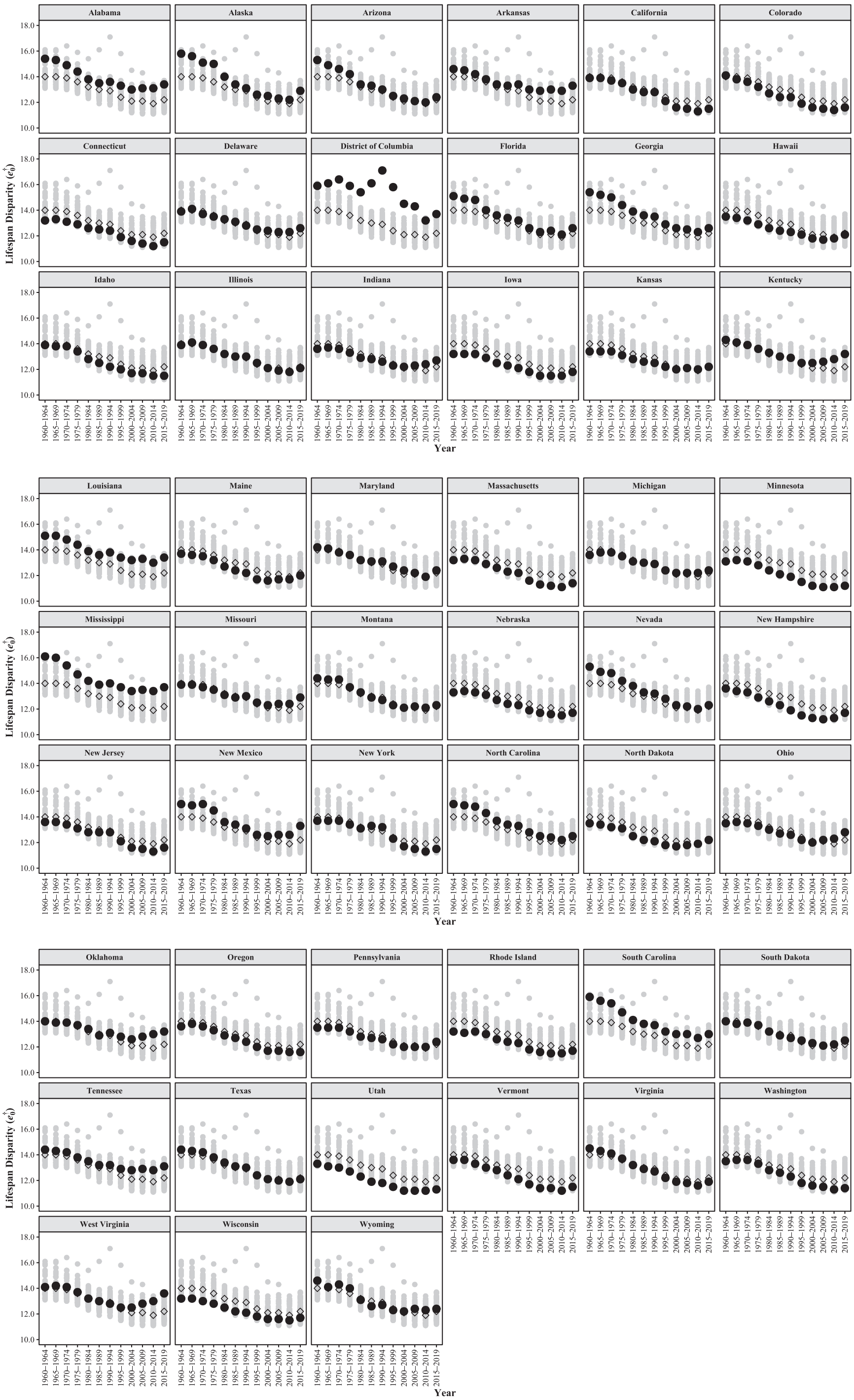

Fig. 2 Trends in lifespan disparity at birth ($e_0^\dagger$) by state from 1960–1964 to 2015–2019. Each panel displays trends in lifespan disparity for an individual state or D.C. (black circles) relative to all other states (gray circles) and the national average (diamonds) in each five-year period.

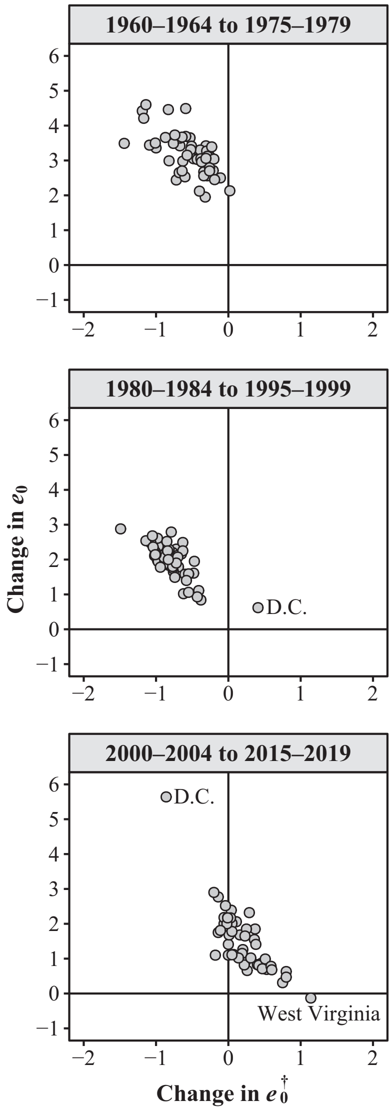

Fig. 3 Change in lifespan disparity ($e_0^\dagger$) and life expectancy (e_0) at birth among states in three time periods

Valley and Appalachia (e.g., Indiana, Kentucky, Ohio, and West Virginia) saw their relative position worsen between 1960–1964 and 2015–2019. In contrast, relative standing improved for some states along the East Coast (e.g., Georgia and Virginia) and in the West (e.g., Colorado and Nevada). As noted earlier, clusters of states in the Northeast, Upper Midwest, and West displayed consistently low lifespan variability throughout the study period.

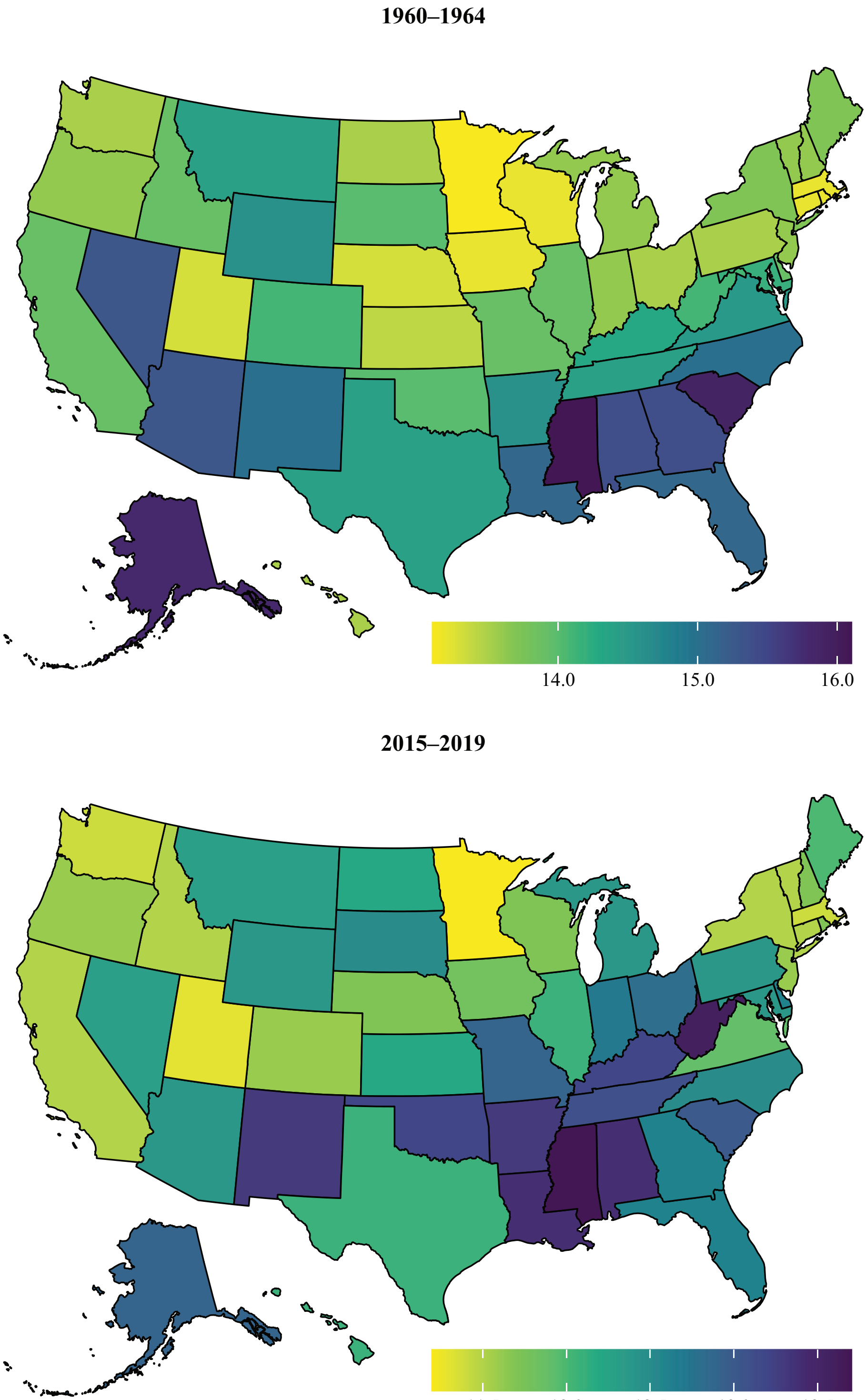

Fig. 4 Maps of lifespan disparity at birth ($e_0^\dagger$) by state in 1960–1964 and 2015–2019

Sensitivity Analyses

We examined the robustness of our conclusions to two alternative specifications. First, we estimated each state's $e_0^\dagger$ for women and men separately. Sex-specific results within states largely mirrored those documented in the total population. Lifespan variability was lower among women than men in each state and five-year period (see online supplement Tables S1 and S2). Second, we truncated deaths among infants and children and examined trends in $e_{10}^\dagger$. Prior studies have argued that including infant and child deaths may bias results because these deaths occur far below the mean age at death (Edwards and Tuljapurkar 2005). The $e_{10}^\dagger$ values were lower than $e_0^\dagger$ values, but truncation at age 10 did not alter our substantive conclusions.

Discussion

Lifespan variability declined over time for all states, but sizable disparities remain between states. These disparities generally align with states' varied demographic, cultural, and socioeconomic contexts. For instance, southern and Appalachian states experience higher levels of poverty and poor health than other parts of the country (Fenelon 2013), and these states exhibit persistently higher levels of lifespan variability. Additionally, states vastly differ in their policy contexts regarding social inequality, such as Medicaid expansion, Earned Income Tax Credit, tobacco control, and setting a minimum wage above the federal level (Montez et al. 2020). Policies that alleviate poverty and promote educational and occupational opportunities may be especially effective for averting preventable, early-life deaths that contribute disproportionately to lifespan variability (van Raalte et al. 2018). State policies that curtail early-life mortality would have the dual benefit of increasing life expectancy while simultaneously decreasing lifespan inequality. By adopting more progressive policies found in most low-variability states, high-variability states have the potential to extend the lives of their most vulnerable residents, reduce lifespan variability, and close the population health gaps between the leading and lagging states.

Our results uncovered a worrisome trend of *increasing* lifespan disparity within many states. Decompression (i.e., rising lifespan variability) occurred in D.C. during the late 1980s and early 1990s, in West Virginia since 2000–2004, and in nearly every state in the most recent period (2010–2014 to 2015–2019). These reversals are consistent with research in the United States documenting falling life expectancy (Arias and Xu 2020), rising midlife mortality (Masters et al. 2017; National Academies of Sciences, Engineering, and Medicine 2021), and increasing lifespan variability (Acciai and Firebaugh 2019; Rogers et al. 2020). Although more research is needed to identify the reasons behind increases in lifespan variability, evidence suggests that rising accidental poisoning and suicide deaths among younger adults are contributing factors (Acciai and Firebaugh 2017).

Limitations

Our study has two notable limitations. First, analyses of more granular geographic units may provide more nuanced insights into geographic disparities in lifespan variability over time. Mortality rates and life expectancy differ widely between other substate geographic levels, such as counties or metropolitan areas (Chetty et al. 2016; Elo et al. 2019; Ezzati et al. 2008), and similar patterns may exist for lifespan variability. Second, our analyses do not examine how contextual and compositional differences contribute to divergent trends in lifespan variability between states. Future studies should combine USMDB data with state-level demographic, socioeconomic, and policy data to address this limitation. Such analyses should particularly focus on trends starting in the 1970s and 1980s, the period when declines in lifespan variability began to slow and state policy environments concurrently diverged.

Conclusions

Our study demonstrates substantial state-level heterogeneity in lifespan variability in the United States since the 1960s. Differences in the magnitude and degree of change of mortality compression have led to stagnant, and in some instances growing, inequalities in lifespan variability across states. Thus, state-level disparities in mortality rates and life expectancy extend to state differences in lifespan variability. These patterns are consistent with mounting evidence that geographic disparities in population health have grown over time. Researchers should continue to monitor state-level inequality in lifespan variability because doing so will provide policymakers with valuable information that they could leverage to improve population health. ■

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