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Trends and structural factors affecting health equity in the United States at the local level, 1990–2019

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ABSTRACT

Health equity is fundamental to improving the health of populations, but in recent decades progress towards this goal has been mixed. To better support this mission, a deeper understanding of the local heterogeneity within population-level health equity is vital. This analysis presents trends in average health and health equity in the United States at the local level from 1990 to 2019 using three different health outcomes: mortality, self-reported health status, and healthy days. Furthermore, it examines the association between these measures of average health and health equity with several structural factors. Results indicate growing levels of geographic inequality disproportionately impacting less urbanized parts of the country, with rural counties experiencing the largest declines in health equity, followed by Medium and Small Metropolitan counties. Additionally, lower levels of health equity are associated with poorer local socioeconomic context, including several measures that are proxies for structural racism. Altogether, these findings strongly suggest social and economic factors play a pivotal role in explaining growing levels of geographic health inequality in the United States. Policymakers invested in improving health equity must adopt holistic and upstream approaches to improve and equalize economic opportunity as a means of fostering health equity.

1. Introduction

Health equity, which has been defined as the conditions under which "everyone has a fair and just opportunity to be as healthy as possible," (Braveman, 2017) is fundamental to improving the health of populations. However, despite widespread acknowledgement of its importance (Healthy People 2030, 2020; Plough, 2015), progress towards achieving health equity has been mixed in recent decades. While children and adolescents have benefitted from improvements in the several decades leading up to the pandemic (Anderson & Zimmerman, 2021a), working-age adults have experienced substantial declines in health equity across a comprehensive set of measures including all-cause mortality (Anderson and Zimmerman 2021b) and subjective health status (Zimmerman & Anderson, 2019). These recent patterns are evidence that there is a lot of room for improvement in health equity.

Despite the overall declines in health equity among working-age adults, there may be meaningful heterogeneity across local contexts, with some counties doing substantially better or worse than the state or national averages. Woolf (2017), for example, calls for "widening the health equity lens" to include a greater focus on health equity in economically depressed rural communities. Understanding these more granular trends can form the basis for efforts to improve health equity in the future in several respects. First, identifying poorly performing areas allows policymakers to identify where additional resources can be allocated. Second, analyzing the characteristics of better-performing areas can provide insight on what works and form the basis for more effective policy. Notwithstanding its importance, we were unable to find any published research specifically testing the association of local conditions or of rurality with health equity in the U.S.

One part of the socio-political context that deserves special attention with respect to promoting health equity at the local level is structural racism, which has been defined as "the macrolevel systems, social forces, institutions, ideologies, and processes that interact with one another to generate and reinforce inequities among racial and ethnic groups" (Gee & Ford, 2011). While it has been clearly demonstrated that structural racism is associated with poorer levels of health at the local level (Dougherty et al., 2020; Tan et al., 2021), more work is needed to clarify the specific mechanisms affecting particular aspects of health equity.

This study documents the trends in average health and health equity for several key indicators of population health at the local level in the

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United States from 1990 to 2019. Furthermore, we analyze the relationship between health equity and several structural factors, including structural racism.

2. Material and methods

2.1. Data

Since health is a multidimensional construct, any single indicator may not adequately describe progress towards health equity (Harper et al., 2010; Hoyer et al., 2022; Kindig et al., 2018). Therefore, we analyze three separate indicators of population health: mortality, self-reported health status, and healthy days. These three indicators are chosen because they have been used in previous studies of population health (e.g., the County Health Rankings and Roadmaps model: Booske et al., 2010), and because they have been validated as strong measures of population health (Hagerty et al., 2001). These measures are correlated, but not perfectly so, and measure slightly different aspects of population health. Previous work has demonstrated similar, but not identical trends in health equity across the 3 outcomes (Anderson and Zimmerman 2021b; Zimmerman & Anderson, 2019).

Data for this study are from the CDC National Center for Health Statistics. Mortality is calculated using restricted use data of all deaths from 1990 to 2019 from CDC Vital Statistics (National Center for Health Statistics, 1990-2019). We omit nonresidents, and assign county based on the deceased's location of residence, rather than the occurrence of death. We calculate mortality denominators using a combination of Surveillance Epidemiology and End Results (SEER) population estimates (National Cancer Institute, 2019) and Census data available from the IPUMS-USA database at the University of Minnesota (Ruggles et al., 2020). More information on technical aspects of working with this data can be found in prior published work (Anderson and Zimmerman 2021b).

Self-reported health and healthy days are calculated from restricted use Behavioral Risk Factor Surveillance System (BRFSS) data from 1994 to 2019 (Centers for Disease Control and Prevention, 1994-2019). Self-reported health is on a 5-point scale (excellent; very good; good; fair; and poor), with values reweighted based on a previously established methodology (Van Doorslaer & Jones, 2003). Healthy days is constructed from two questions assessing the total number of days not in poor physical or mental health in the past month, which are worded as follows:

> "Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?"

> "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?"

Responses were provided as a whole number from 0 to 30, summed together across the mental and physical health measures, top-coded at 30, and finally inverted such that a higher number corresponded to a positive outcome. See Appendix Table 1 for additional summary statistics.

We aggregate BRFSS data into three-year periods to increase sample size, reporting estimates as the last year in the period.

Although our focus is on the non-elderly adult population (18–64), for mortality analyses we focus on the population aged 25–64, as these are the ages at which socioeconomic information needed to construct our health equity estimates is reliably available (Bosworth, 2018). Additionally, certain county-level data is missing throughout the sample: for mortality data, Hawaii is unavailable from 1990 to 1999 and several other county-year combinations (not disclosable for privacy reasons); for BRFSS data, Alaska is unavailable for the entire period, and 29 states did not field the healthy days questions in 2002. The number of total records assessed is 18,213,733 for mortality, 5,834,804 for self-reported health, and 5,053,614 for healthy days (see Appendix Table 2 for a yearly breakdown of these totals).

Since many counties are not populous enough to generate reliable population-level estimates, we focus on the following geographic areas when analyzing trends: 1) groupings of contiguous counties within states (319 total, see Appendix Table 3 for more detail), which allow for full coverage of the United States; and 2) a modification of Urban-Rural Classification Scheme for all Counties provided by NCHS in 2013, where we consolidate medium and small metropolitan counties, as well as micropolitan and noncore counties into a rural classification (Ingram & Franco, 2014).

When analyzing relationships between structural factors and local health, we focus on a subset of county-level estimates (see Appendix Table 4). For mortality, to achieve relatively stable estimates for a comparatively rare outcome, we initially consider the largest 424 counties, which approximates those with a population of 150,000 or more, and consist of roughly three-fourths of the total United States population. For BRFSS outcomes, we initially restrict to the 2032 counties with a sample of at least 64 respondents for all periods between 2011 and 2013 to 2017–2019, and consist of roughly nine-tenths of the total United States population. Since structural racism is a key area of focus in this analysis, we further restrict the regression sample to counties with at least a 1% share of Black and Latinx residents (mortality models: 398 and 424 counties, respectively; self-reported health and healthy days models: 1367 and 1926 counties, respectively). Appendix Figure 1 maps these exclusion criteria for each set of analyses.

2.2. Exposure variables and potential confounders

County-level information on demographics and socioeconomic factors are from 5-year American Community Survey estimates, where data is assigned to the last year in the period. Socioeconomic conditions, which represent the exposure of interest, include the percentage of residents in poverty, the percentage of residents over aged 25 who hold a college degree, and percentage of residents in the labor force over aged 16 who are unemployed. Each of these exposure measures is calculated as the overall rate among the population.

To capture structural racism effects, the exposures of interest (poverty, college completion, and unemployment) are separately calculated as the difference between those for Whites and Blacks and between those for Whites and Latinx. Two different strategies have emerged to measure structural racism. One is based in observable policies that may systematically create racialized economic and social outcomes. For example, Agénor et al. catalogued a large list of such laws, out of which a state-level index can be created to proxy for structural racism (Agénor et al., 2021). Other efforts focus on observable disparities in relevant outcomes between disadvantaged and privileged groups. O'Brien et al., for example, focus on the inter-generational persistence of placement in the income distribution (O'Brien et al., 2020). The disparities measures that we use are in line with the observable outcomes approach rather than the focus on laws. We adopt this approach since our analysis of structural racism focuses on within sub-state geographies, for which state laws are not as useful.

Potential confounders that we additionally control for include age distribution (18–34, 35–49, and 50–64) and racial/ethnic composition (White, Black, Latinx, and Other or Multiple). Furthermore, in models examining measures of structural racism, we control for the rate of the exposure of interest within the White population.

2.3. Analytic method

Each of the outcomes (mortality, self-reported health, and healthy days) is calculated in two ways: average health and a Health Equity Metric (HEM). In order to facilitate directional comparability across outcomes, mortality is coded such that a positive value corresponds to

better health (i.e., what is referred to as "average morality" in this analysis is actually life expectancy). The Health Equity Metric is constructed following previously published research (Zimmerman, 2019). It requires calculating the average deficit of individual health from a benchmark level of health corresponding to the average health within a privileged population, defined here as White men with a college education. As health equity has been formally defined as everyone having an opportunity to be as healthy as possible, the average health of this privileged group is accordingly used as the benchmark for what it means to be as healthy as possible. If all members of a population have a level of health at or above this value, this represents achieving true health equity (Zimmerman, 2019). Levels of individual health that do not reach this benchmark are handled in the following way: larger deficits are weighted greater than multiple smaller deficits, to reflect greater health inequity associated with very adverse health outcomes. A formal definition of the Health Equity Metric can be found in Appendix A, and more technical information on how the HEM is calculated is presented in previous work (Anderson & Zimmerman, 2021a, 2021b; Zimmerman, 2019; Zimmerman & Anderson, 2019).

Following the descriptive analyses of trends in average health and health equity, we regress county-level estimates of average health and the Health Equity Metric for each outcome on the exposure measures, while controlling for the potential confounders described above and we account for year trends and county-level fixed effects, the latter of which

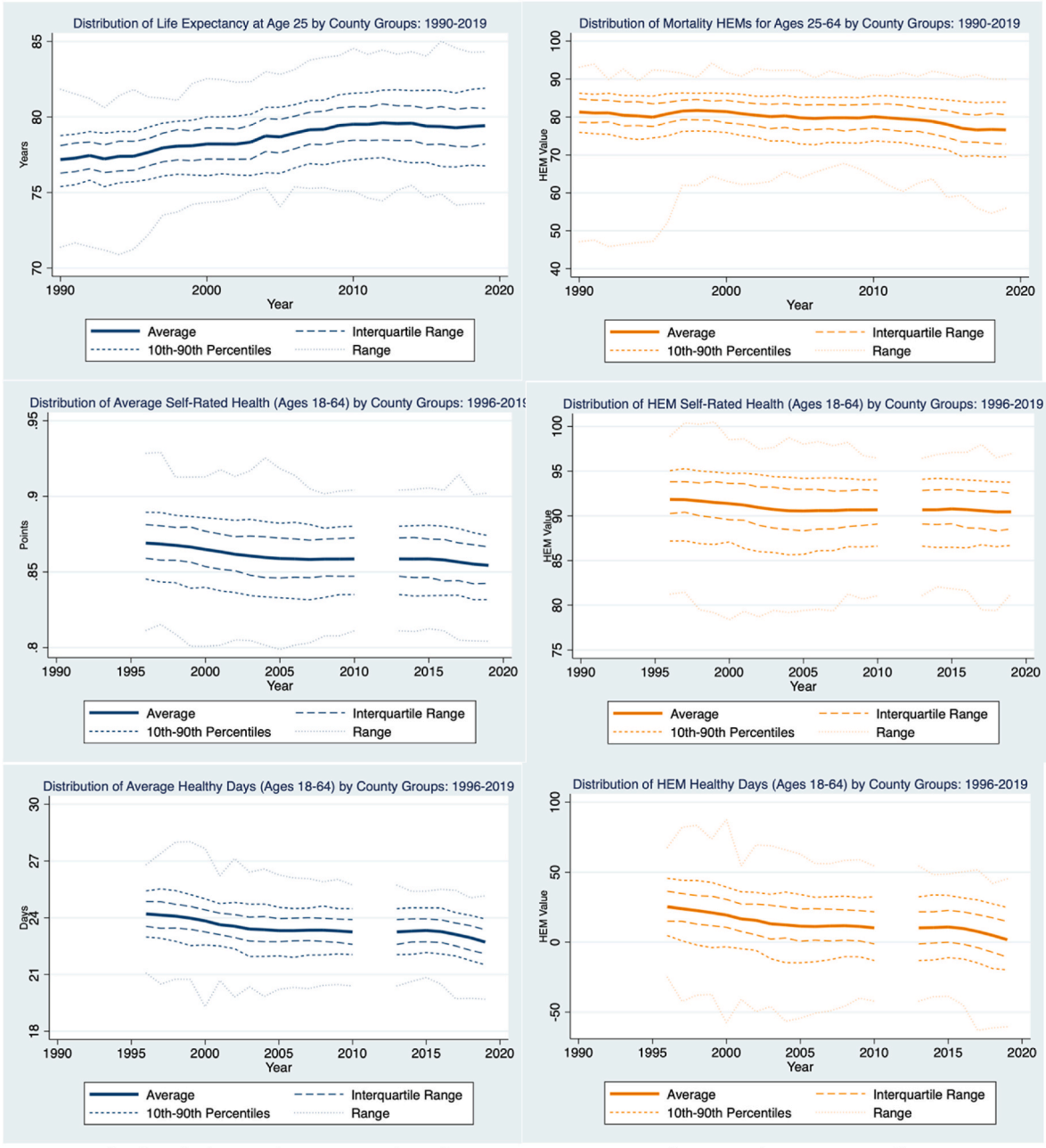

Fig. 1. Distribution of County Grouping Average Health and Health Equity Metric Scores, 1990-2019. Notes: See Appendix Table 3 for County Groups definitions. Self-Reported Health and Healthy Days estimates are based on three-year aggregated files, where the data is assigned to the last year in the period. The gap between 2010 and 2013 in each of the BRFSS outcomes reflects changes to the sampling and weighting procedures of the complex survey design, which resulted in estimates up to 2010 not being comparable with those from afterwards (Centers for Disease Control and Prevention, 2012). Additionally, estimates from 1996 to 2010 are shifted so that 2010 value matches that of 2013, in order to account for complex survey redesign which occurred between 2010/2011. Source: Author's Calculations from National Vital Statistics System and Behavior Risk Factor Surveillance System

is done with the *fe* option in STATA which calculates the "within" estimator.

Due to a study redesign in the BRFSS sampling and weighting procedure, estimates between 2010 and 2011 are not directly comparable (Centers for Disease Control and Prevention, 2012). As such, we make several adjustments to analyses of self-reported health and healthy days outcomes. First for descriptive trends, we do not calculate estimates for any periods containing both 2010 and 2011, and we shift the estimates in the periods prior to 2010 so that there is no change in the outcome between the 2008–2010 and 2011–2013 periods. This has the effect of biasing any trend analyses towards the null. Second, for regression analyses analyzing self-reported health and healthy days, we restrict the analysis period from 2011 to 2013 through 2017–2019, since only one additional data point (2008–2010) could be considered in the pre-redesign period.

3. Results

Fig. 1 plots descriptive statistics for the county group estimates of average health and the Health Equity Metric over the course of the entire study period (see Appendix Table 1 for point estimates in select years). Across the measures, there is little evidence of progress over the study period, as five out of the six had lower scores in 2019 compared to 1990; only average mortality rates in counties show overall improvement over time. For mortality, trends for average health and health equity were divergent: life expectancy at age 25 increased from 77.19 years in 1990

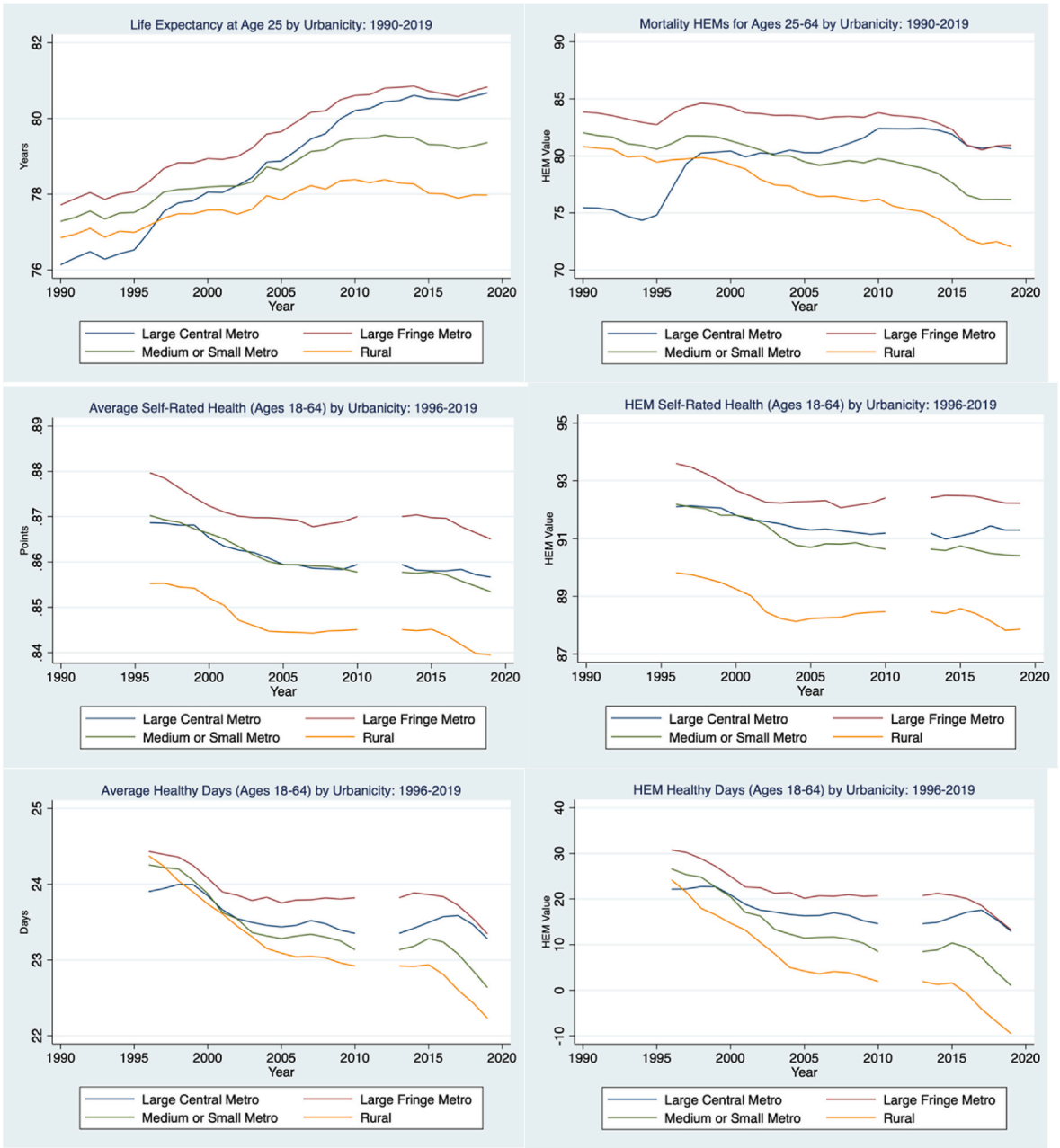

Fig. 2. Trends in Average Health and Health Equity Metric Scores by Urbanicity, 1990-2019. Notes: Self-Reported Health and Healthy Days estimates are based on three-year aggregated files, where the data is assigned to the last year in the period. The gap between 2010 and 2013 in each of the BRFSS outcomes reflects changes to the sampling and weighting procedures of the complex survey design, which resulted in estimates up to 2010 not being comparable with those from afterwards (Centers for Disease Control and Prevention, 2012). Additionally, estimates from 1996 to 2010 are shifted so that 2010 value matches that of 2013. Source: Author's Calculations from National Vital Statistics System and Behavior Risk Factor Surveillance System

to 79.42 years in 2019, whereas the Health Equity Metric declined from 81.31 points to 76.64 points over the same period. Notably, this divergence was not present for other indicators of self-reported health and healthy days, all of which declined over the study period.

Of note, heterogeneity in both measures of mortality increased over time, as measured by the standard deviation of county group estimates (from 1.35 in 1990 to 1.87 in 2019 for average health [$p < 0.001$ based on a robust test of variances] and from 5.12 in 1990 to 5.54 in 2019 for the HEM [$p < 0.005$]). However, for self-reported health, heterogeneity decreased (standard deviation went from 0.018 in 1996 to 0.017 in 2019 for average health [p-value of the difference = 0.66] and from 3.07 in 1990 to 2.77 in 2019 for the HEM [$p = 0.33$]) while trends were more mixed for healthy days (standard deviation went from 0.98 in 1996 to 0.95 in 2019 for average health [$p = 0.90$] and from 16.16 in 1990 to 17.79 in 2019 for the HEM [$p = 0.07$]).

Fig. 2 displays trends in the several indicators of health by urbanicity over the study period. Again, several notable patterns emerge. First, with respect to mortality, both average health and the HEM disproportionately increase for Large Central Metro counties (average health: from 76.1 years in 1990 to 80.7 years in 2019; HEM: from 79.5 points in 1990 to 83.4 points in 2019). The fastest period of growth is in the 1990's (42.2% and 93.9% of the total increase from 1990 to 2017 for average health and the HEM, respectively), but the increases continue throughout the remainder of the study period. Second, across all outcomes, rural counties fare worst with respect to both average health and health equity. In fact, the gap in performance between rural and urban counties by the end of the period is of similar magnitude to the trends over time within geographic areas. Relative to Large Central Metro counties, in 2019 Rural counties performed −1.24 and −1.26 standardized units lower for the HEM metrics of self-reported health and healthy days, respectively, as opposed to −1.01 and −1.10 standardized units lower for average health on those two outcomes.

To better understand potential drivers for differences in trends by urbanicity, we present cause-specific inequities in mortality between 1990 and 2019 in Fig. 3. These estimates can be thought of as a reweighted number of years of potential life lost assigned to broad categories of mortality, such as heart disease, cancer, suicide, etc. (see Appendix A for more information). Several results are worth mentioning. First, much of the improvement in mortality for Large Central Metros with respect to health equity is driven by rapid declines in HIV deaths over the 1990's, with inequities peaking at 5.0 points in 1994 but falling to 1.2 points by 2000. Second, inequities from deaths attributed to suicide, liver disease, and drug overdose, which are commonly referred to as deaths of despair in the literature (Case & Deaton, 2015), are similar across urbanicity in 2019 (4.2 points in Large Central Metro counties, 4.2 points in Fringe Metro counties, 4.8 points in Medium or Small Metro counties, and 4.6 points in Rural counties). Rather, the worsening performance for Rural counties relative to other portions of the county appears to be driven by larger inequities attributable to chronic disease. Altogether, inequities from cancer, heart disease, diabetes, and other chronic diseases changed by +2.0 points between 1990 and 2019 for Rural counties, as opposed to −1.0, −0.3, and +0.8 points for Large Central Metro, Large Fringe Metro, and Medium or Small Metro counties, respectively.

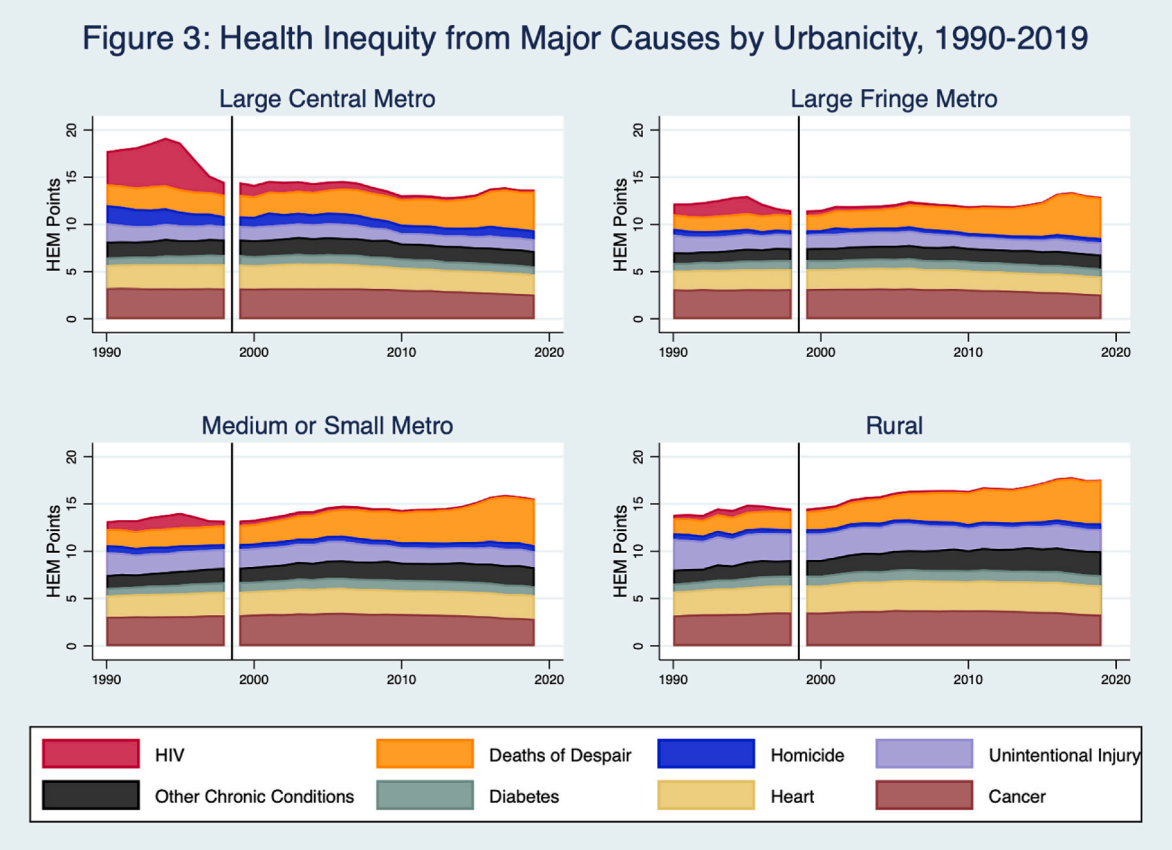

Fig. 3. Health Inequity from Major Causes by Urbanicity, 1990-2019. Notes: This figure shows health inequity, as opposed to previous figures which show health equity. Health inequity for all causes sums up to the distance between the national Health Equity Metric and 100. Causes in the key are arranged from top to bottom in the figure. Deaths of Despair include mortalities attributed to drug overdose, suicide, and alcohol-related liver disease. Chronic conditions include mortalities attributed to respiratory disease, stroke, Alzheimer's, kidney disease, flu, septicemia, and hypertension. Black vertical line represents the change from ICD-9 to ICD-10 cause of death coding. We adopt the comparability ratio methodology proposed by Anderson to make the two periods more comparable (R. N. Anderson et al., 2001). Source: Author's Calculations from National Vital Statistics System.

Table 1 presents regression results testing associations of indicators of average health and health equity with economic and structural racism (see Appendix Table 5 for descriptive statistics for observations considered in this analysis). Health outcomes are standardized and transformed such that coefficients indicate the standard deviation change in the outcome associated with a 10-percentage point increase in the covariate.

Several noteworthy findings emerge. First, better performance on county-level socioeconomic measures is typically associated with higher levels of average health and health equity, as seen in Model 1. For example, a 10-percentage point increase in the poverty rate is associated with a 0.35 standardized-unit reduction in average self-reported health [95% CI: 0.41 to −0.29]. Similarly, a 10-percentage point increase in local average college attainment is associated with a 0.08 standardized unit improvement in average self-reported health [95% CI: 0.01–0.16], and a 10-percentage point increase in unemployment is associated with a 0.21 standardized unit decrease in average self-reported health [95% CI: 0.27 to −0.14]. The major exception to this pattern is the case of mortality, where higher levels of poverty are associated with better county-level life expectancy ($\beta = 0.08$; [95% CI: 0.01–0.14]) and unemployment has a nonsignificant association ($\beta = 0.06$; [95% CI: 0.0001 - 0.12]).

Secondly, higher levels of structural racism are often associated with worse average health and health equity, as seen in Model 2. For average self-reported health, a 10-percentage point increase in the Black-White College Attainment Gap is associated with a −0.03 standardized unit change in average self-reported health [95% CI: 0.04 to −0.01], and a 10-percentage point increase in the Black-White Unemployment Gap is associated with a −0.03 standardized unit change in average self-reported health [95% CI: 0.01 to −0.05]. A 10-percentage point increase in the Black-White College Attainment Gap is associated with a −0.03 standardized unit change in average self-reported health [95% CI: 0.05 to −0.01]. The clear exception occurs with the Latinx-White unemployment gap (Average mortality, i.e., life expectancy: $\beta = 0.04$ [95% CI: 0.003–0.08]; HEM mortality: $\beta = 0.09$ [95% CI: 0.04–0.15]).

4. Discussion

Achieving health equity is a critical aim for population health. However, success in this mission requires a detailed understanding of variation at the local level, so that research can identify and guide implementation of policy that would concretely improve health equity throughout the country. By examining the trends in average health and health equity at the county level in the United States over the past several decades, this analysis yields several important insights. In what follows, we briefly discuss the general patterns this descriptive work has revealed, the contributions to existing literature, and the implications for policy and practice.

4.1. General patterns in health and health equity

There has been a pervasive lack of progress towards health equity over this period. Across three indicators of health – mortality, self-reported health, and healthy days in the past month – trends in health equity are negative. This result is consistent with prior research (Anderson and Zimmerman 2021b; Zimmerman & Anderson, 2019), and extends it by examining geographic and in particular rural vs urban differences. In this context, there is clear evidence of growing geographic inequality, as evidenced by a greater variation in county-level health by 2019. This phenomenon appears to be disproportionately affecting less urbanized parts of the country, with Rural counties experiencing the largest declines in health equity, followed by Medium and Small Metropolitan counties.

The explicit focus on health equity here reveals a deeply troubling state of affairs that may be underappreciated when examining standard measures of population health outcomes. For example, the trends in mortality health equity by urbanicity reveal a strong and consistent decline over the entire 30-year period, whereas life expectancy only began to decline in Rural counties around 2012. In this sense, the decline in health equity was an early warning sign for overall decreasing health, a sign that would have missed by looking only at population averages.

Additionally, disparities by urbanicity are noteworthy. More specifically, the disparities across rural and urban areas in health equity for self-reported health and healthy days are wider in 2019 than the disparities in average health. The point is a subtle one, but important: geographic disparities in health disparities in the U.S. are growing larger. Not only are rural areas lagging in their health, but they are becoming sites of a growing crisis in health equity.

Importantly, this is not a story of disproportionately increasing levels of deaths of despair in rural counties. Examining inequities by cause of death suggest that this growing disparity may be the result of a long-term increase in chronic health conditions, rather than a sharp uptick in more acute threats to health. Second, higher inequities are associated with poorer local socioeconomic context, including several outcomes that are proxies for structural racism.

4.2. Contributions to the existing literature

Systematic investigation of health equity—as opposed to specific health disparities—is in its infancy. Existing conceptual literature has forcefully made the point that health equity—which involves assessing the capacity of everyone to be as healthy as possible given the constraints of technology, national economic development, and genetics (Braveman et al., 2018)—is distinct from health disparities—which are concerned only with differences in group averages across very broadly defined groups, typically racial/ethnic groups (Kindig, 2017; Liburd et al., 2020). Yet measurement of health equity too often continues to default to examining disparities (Braveman et al., 2017; Kneipp et al., 2018). This practice misses the very consequential developments for health equity that have arisen through increasing economic stratification in the US, where two trends are intertwined: rising income inequality and a greater gradient of health with income (i.e., the fact that the relationship between income and health has become steeper over time: Bor et al., 2017; Case & Deaton, 2015; Chetty et al., 2016).

One recent analysis usefully examines the association of county-level economic inequality and deaths of despair (Kuo & Kawachi, 2023). Higher economic inequality was associated with poorer health outcomes across several Black, Latinx, and White groups defined by race or ethnicity. Although the health equity impact was not formally tested, the estimated adjusted relative risk ratios were very similar across these groups defined by race or ethnicity, suggesting that income inequality is associated with more deaths of despair, but not with greater disparity in deaths of despair. The results here support that finding, in that here too, deaths of despair were not found to be a driver of worsening health equity.

The Kuo and Kawachi study also found that lower average social mobility was associated with greater deaths of despair across all groups defined by race or ethnicity, and that the magnitude was greater among Blacks than among Whites. Such results are suggestive that social mobility—unlike income inequality—may play a role in health equity. This study extends these results by testing whether *racially-patterned* social mobility, rather than social mobility overall, is associated with health equity, and finds that indeed, structural racism in social mobility is associated with worse health equity.

We were unable to find any prior published work that tested any measure of health equity across local geographic areas (e.g., counties, cities, neighborhoods) with attention to the rural-urban divide. This is a serious shortcoming in the literature given the anecdotal (Woolf, 2017) and empirical (Lee et al., 2023; Loccoh et al., 2021; Miller & Vasan, 2021) recognition that rural areas are increasingly lagging in health.

Prior research has shown that there are geographic differences within the United States in trends of health equity. A recent study across

Table 1
Regression of county-level measures of average and equitable health on socioeconomic factors and structural racism, 2013–2019

	Average Health				Health Equity Metric			
	Black-White Disparities		Latinx-White Disparities		Black-White Disparities		Latinx-White Disparities	
	Model 1)	Model 2)	Model 1)	Model 2)	Model 1)	Model 2)	Model 1)	Model 2)
a) Mortality[a]								
Overall Structural Factors								
Percent of Population 18+ in Poverty	0.077[c]		0.076[c]		0.078[c]		0.069 (0.046)	
	(0.032)		(0.031)		(0.048)			
Percent of Population 25+ with College Degree	0.171[e]		0.169[e]		−0.033		−0.057	
	(0.044)		(0.043)		(0.066)		(0.064)	
Unemployment for Population 16+	0.061[b]		0.032 (0.030)		0.071 (0.047)		0.037 (0.045)	
	(0.031)							
Structural Racism Factors								
Poverty Gap with White Population		−0.008		−0.052[e]		−0.044[c]		−0.100[e]
		(0.012)		(0.012)		(0.019)		(0.018)
Poverty Rate Among White Population		−0.139[d]		−0.086[b]		−0.211[d]		−0.146[c]
		(0.048)		(0.046)		(0.074)		(0.069)
College Attainment Gap with White Population		−0.024		−0.046[d]		−0.003		−0.071[d]
		(0.0151)		(0.016)		(0.024)		(0.024)
College Attainment Rate Among White Population		0.315[e]		0.351[e] (0.037)		0.059 (0.057)		0.129[c]
		(0.037)						(0.056)
Unemployment Gap with White Population		0.018 (0.016)		0.041[c] (0.019)		0.043[b]		0.092[d]
						(0.025)		(0.029)
Unemployment Rate Among White Population		0.366[e]		0.367[e] (0.029)		0.517[e]		0.534[e]
		(0.029)				(0.044)		(0.043)
Additional Covariates								
Year	−0.002	−0.001	−0.001	−0.001[d]	−0.005[e]	−0.004[e]	−0.005[e]	−0.005[e]
	(0.004)	(0.004)	(0.001)	(0.0004)	(0.001)	(0.001)	(0.001)	(0.001)
Percent of Population Aged 18-34	−0.202[c]	−0.326[e]	−0.242[d]	−0.386[e]	−0.054	−0.216	−0.077	−0.293[c]
	(0.092)	(0.089)	(0.089)	(0.087)	(0.138)	(0.136)	(0.133)	(0.131)
Percent of Population Aged 35-49	0.976[e]	0.711[e]	0.792[e]	0.510[e] (0.087)	1.710[e]	1.493[e]	1.542[e]	1.256[e]
	(0.096)	(0.092)	(0.090)		(0.144)	(0.139)	(0.134)	(0.130)
Percent of Population Aged 50-64	0.912[e]	0.605[e]	0.734[e]	0.490[e] (0.079)	0.891[e]	0.584[e]	0.679[e]	0.447[e]
	(0.085)	(0.084)	(0.080)		(0.129)	(0.127)	(0.120)	(0.118)
Percent of Population White, non-Latinx	−0.752[e]	−0.699[e]	−0.766[e]	−0.698[e]	−1.022[e]	−1.015[e]	−0.995[e]	−0.956[e]
	(0.066)	(0.064)	(0.065)	(0.063)	(0.100)	(0.097)	(0.096)	(0.094)
Percent of Population Black, non-Latinx	−1.060[e]	−0.884[e]	−1.090[e]	−0.926[e]	−1.426[e]	−1.342[e]	−1.416[e]	−1.344[e]
	(0.088)	(0.087)	(0.086)	(0.085)	(0.132)	(0.131)	(0.129)	(0.128)
Percent of Population Latinx	−0.627[e]	−0.592[e]	−0.644[e]	−0.567[e]	−0.716[e]	−0.696[e]	−0.715[e]	−0.608[e]
	(0.072)	(0.066)	(0.071)	(0.066)	(0.108)	(0.101)	(0.106)	(0.099)
N (number of counties)	398	398	424	424	398	398	424	424

	Average Health				Health Equity Metric			
	Black-White Disparities		Latinx-White Disparities		Black-White Disparities		Latinx-White Disparities	
	Model 1)	Model 2)	Model 1)	Model 2)	Model 1)	Model 2)	Model 1)	Model 2)
b) Self-Reported Health								
Overall Structural Factors								
Percent of Population 18+ in Poverty	−0.348[e]		−0.325[e]		−0.325[e]		−0.293[e]	
	(0.030)		(0.034)		(0.034)		(0.028)	
Percent of Population 25+ with College Degree	0.082[c]		0.105[c]		0.105[c]		0.099[d]	
	(0.039)		(0.044)		(0.044		(0.036)	
Unemployment for Population 16+	−0.206[e]		−0.168[e]		−0.168[e]		−0.136[e]	
	(0.035)		(0.039)		(0.039)		(0.033)	
Structural Racism Factors								
Poverty Gap with White Population		0.001 (0.007)		0.001 (0.008)		0.001 (0.008)		−0.006
								(0.007)
Poverty Rate Among White Population		−0.016		−0.004		−0.114[c]		−0.083[c]
		(0.041)		(0.006)		(0.047)		(0.038)
College Attainment Gap with White Population		−0.025[c]		−0.030[e]		−0.030[d]		−0.015
		(0.010)		(0.011)		(0.011)		(0.010)
College Attainment Rate Among White Population		0.061[b]		−0.008		0.067[b]		0.074[c]
		(0.035)		(0.009)		(0.040)		(0.033)
Unemployment Gap with White Population		−0.028[d]		−0.016		−0.016		0.004 (0.010)
		(0.010)		(0.011)		(0.011)		
Unemployment Rate Among White Population		−0.373[e]		−0.006		−0.275[e]		−0.287[e]
		(0.029)		(0.009)		(0.033)		(0.028)
Additional Covariates								
Year	−0.006[e]	−0.005[e]	−0.006[e]	−0.005[e]	−0.003[e]	−0.004[e]	−0.004[e]	−0.004[e]
	(0.0004)	(0.0003)	(0.0004)	(0.0003)	(0.001)	(0.0004)	(0.0004)	(0.0004)
Percent of Population Aged 18-34	−0.229[c]	−0.118	−0.199[c]	−0.108	−0.204[b]	−0.107	−0.207[c]	−0.126
	(0.095)	(0.096)	(0.081)	(0.081)	(0.108)	(0.109)	(0.091)	(0.092)
Percent of Population Aged 35-49	−0.124	0.132 (0.098)	−0.053	0.170[c]	−0.074	0.139 (0.112)	−0.047	0.132 (0.190)
	(0.098)		(0.080)	(0.080)	(0.111)		(0.090)	

(*continued on next page*)

Table 1 (*continued*)

	Average Health				Health Equity Metric			
	Black-White Disparities		Latinx-White Disparities		Black-White Disparities		Latinx-White Disparities	
	Model 1)	Model 2)	Model 1)	Model 2)	Model 1)	Model 2)	Model 1)	Model 2)
Percent of Population Aged 50-64	−0.434[e]	−0.198[c]	−0.365[e]	−0.179[c]	−0.393[e]	−0.214[c]	−0.357[e]	−0.202[c]
	(0.088)	(0.087)	(0.070)	(0.069)	(0.100)	(0.099)	(0.079)	(0.079)
Percent of Population White, non-Latinx	0.140[b]	0.183[c]	0.151[b]	0.155[c]	−0.056	−0.025	−0.102	−0.067
	(0.072)	(0.072)	(0.062)	(0.062)	(0.082)	(0.082)	(0.070)	(0.070)
Percent of Population Black, non-Latinx	−0.198[c]	−0.256[e]	−0.233[d]	−0.277[d]	−0.168	−0.216[c]	−0.234[d]	−0.263[d]
	(0.090)	(0.091)	(0.079)	(0.080)	(0.102)	(0.104)	(0.089)	(0.091)
Percent of Population Latinx	0.115 (0.082)	0.100 (0.079)	0.121[b]	0.116[b]	0.123	0.095 (0.101)	0.100 (0.081)	0.094 (0.079)
			(0.071)	(0.070)	(0.108)			
N (number of counties)	1367	1367	1926	1926	1367	1367	1926	1926

	Average Health				Health Equity Metric			
	Black-White Disparities		Latinx-White Disparities		Black-White Disparities		Latinx-White Disparities	
	Model 1)	Model 2)	Model 1)	Model 2)	Model 1)	Model 2)	Model 1)	Model 2)
c) Healthy Days								
Overall Structural Factors								
Percent of Population 18+ in Poverty	−0.379[e]		−0.337[e]		−0.333[e]		−0.305[e]	
	(0.038)		(0.031)		(0.037)		(0.031)	
Percent of Population 25+ with College Degree	0.056		0.086[c]		0.125[d]		0.143[e]	
	(0.049)		(0.040)		(0.048)		(0.039)	
Unemployment for Population 16+	−0.591[e]		−0.552[e]		−0.415[e]		−0.387[e]	
	(0.044)		(0.03)		(0.043)		(0.037)	
Structural Racism Factors								
Poverty Gap with White Population		0.006 (0.009)		−0.003		0.008 (0.009)		−0.007
				(0.007)				(0.007)
Poverty Rate Among White Population		0.289[e]		0.255[e]		0.168[d]		0.143[d]
		(0.053)		(0.042)		(0.051)		(0.041)
College Attainment Gap with White Population		−0.047[e]		0.018[b]		−0.042[d]		0.015 (0.011)
		(0.013)		(0.011)		(0.012)		
College Attainment Rate Among White Population		0.206[e]		0.171[e]		0.238[e]		0.204[e]
		(0.045)		(0.038)		(0.044)		(0.037)
Unemployment Gap with White Population		−0.013		−0.009		−0.015		−0.008
		(0.012)		(0.011)		(0.012)		(0.011)
Unemployment Rate Among White Population		−0.530[e]		−0.486[e]		−0.425[e]		−0.398[e]
		(0.037		(0.031)		(0.036)		(0.031)
Additional Covariates								
Year	−0.012[e]	−0.010[e]	−0.012[e]	−0.009[e]	−0.010[e]	−0.009[e]	−0.010[e]	−0.008[e]
	(0.001)	(0.001)	(0.001)	(0.0004)	(0.001)	(0.0004)	(0.001)	(0.0004)
Percent of Population Aged 18-34	−0.525[e]	−0.450[e]	−0.439[e]	−0.385[e]	−0.444[e]	−0.378[d]	−0.375[e]	−0.324[d]
	(0.121)	(0.122)	(0.102)	(0.103)	(0.119)	(0.119)	(0.100)	(0.101)
Percent of Population Aged 35-49	−0.086	0.215[b]	0.032	0.258[c]	−0.079	−0.141	0.043	0.213[c]
	(0.125)	(0.125)	(0.101)	(0.101)	(0.122)	(0.122)	(0.099)	(0.099)
Percent of Population Aged 50-64	0.281[c]	0.711[e]	0.309[e]	0.650[e]	−0.012	−0.275[c]	0.039	0.275[d]
	(0.112)	(0.111)	(0.089)	(0.088)	(0.109)	(0.109)	(0.087)	(0.086)
Percent of Population White, non-Latinx	−0.451[e]	−0.266[d]	−0.424[e]	−0.261[d]	−0.341[e]	−0.197[c]	−0.331[e]	−0.200[c]
	(0.092)	(0.092)	(0.078)	(0.079)	(0.089)	(0.090)	(0.077)	(0.077)
Percent of Population Black, non-Latinx	−0.948[e]	−0.963[e]	−0.910[e]	−0.938[e]	−0.725[e]	−0.709[e]	−0.702[e]	−0.698[e]
	(0.115)	(0.117)	(0.100)	(0.102)	(0.112)	(0.114)	(0.098)	(0.100)
Percent of Population Latinx	0.246[c]	0.279[e]	0.287[d]	0.404[e]	0.260[c]	0.339[d]	0.284[d]	0.356[e]
	(0.104)	(0.101)	(0.090)	(0.089)	(0.102)	(0.099)	(0.089)	(0.087)
N (number of counties)	1367	1367	1926	1926	1367	1367	1926	1926

Notes: Coefficients represent the standard deviation change in the outcome for a 10-percentage point increase in the covariate. All models additionally control for a county-level fixed effect. Models are weighted for the county population aged 18–64. Samples are restricted to counties with a value for all years (2010–2019 for mortality measures and 2013–2019 for others) and to counties with at least a 1% share of the minoritized population (Black and Latinx, respectively) in all years of the outcome.

[a] Mortality outcomes are coded in such a way that a positive value indicates a better outcome, in order to be comparable to the self-reported health and healthy days outcomes. Average health for mortality is equivalent to life expectancy.

[b] $p < 0.10$.

[c] $p < 0.05$.

[d] $p < 0.01$.

[e] $p < 0.001$.

U.S. states found that health equity in life expectancy is lowest in the South and the Ohio River Valley (Anderson and Zimmerman 2021b). This research enhances these findings by offering an explanation for these results, inasmuch as these two regions are both highly rural and exhibit levels of structural racism, at least by the proxies for structural racism used here, the Black-White gap or Latino-White gap in college completion or unemployment. These variables are shown to be highly associated with health equity in this analysis.

4.3. Implications

A lack of progress in health equity has broad implications. Policymakers invested in improving health equity in the United States must adopt holistic and upstream approaches to address the multifaceted determinants of health at the individual and population level (Woolf, 2017, 2019). While more can be done to expand insurance coverage and access through traditional health policies such as Medicaid expansion (Purnell et al., 2016), these efforts must be accompanied with more fundamental improvements to the social conditions that most Americans live in (Lantz, 2019; Lantz et al., 2007). Policies addressing poverty, educational attainment, and unemployment, whether directly or through mediating outcomes such as food insecurity and housing affordability, are vital to the success of the public health mission (Beckfield & Bambra, 2016; Berkowitz, 2022; Courtin et al., 2020; Venkataramani et al., 2021).

Among our findings, we note that both poverty and education have strong associations with life expectancy, but weaker relationships with health equity. On the other hand, structural racism, as identified by Black-White and Latinx-White differences in these measures of socioeconomic opportunity, have a stronger relationship with health equity than they do for overall life expectancy. Moreover, previous research has shown that although Black-White health disparities have improved over time, overall health equity has gotten worse (Anderson and Zimmerman 2021b). Altogether, these findings reinforce the need for a multipronged population health strategy that is sensitive to the required mix of targeted and universalist forms of public policy (Benach et al., 2013). As Heather McGhee has noted, racist public policy adversely affects not only Black and Brown people, but White people too (McGhee, 2021). In that sense, as this research suggests, policies that improve economic and educational outcomes for racial/ethnic minorities can improve health for the population generally. Such policies could include increases in the minimum wage, better worker protections, more affordable housing, and improvements to education, particularly in the low-skilled sector (Dow et al., 2020; Komro et al., 2016; Leifheit et al., 2022; Lens, 2021; Montez et al., 2019; Narain & Zimmerman, 2019; Ye et al., 2023; Zimmerman, 2013).

Examining the growing inequities in mortality by cause of death suggests strategies for addressing health across urban and rural contexts may actually be somewhat similar, despite the inequities across the two settings. First, despite a narrative of rising deaths of despair among white working-age adults in more rural contexts (Stein et al., 2017), rising inequities in mortality from suicide, liver disease, and drug overdose are comparable in more urban areas of the country in recent years (Gennuso et al., 2019). Second, although health inequity from conditions such as cancer, heart disease, diabetes, and other chronic diseases is disproportionately prevalent in Rural counties, these causes make up the majority of health inequity in all other types of counties as well. While these trends have flown somewhat under the radar compared to the causes labeled as deaths of despair, they similarly require upstream and sustained action from health and social policy (Harris et al., 2021).

Structural racism has been gaining greater recognition in recent years as a systemic force influencing population health inequities (Bailey et al., 2017; Gee & Ford, 2011). Findings from our county-level regression analyses confirm these aspects need to be specifically addressed to improve population health. However, differences in findings across types of health outcomes, as well as when examining Black-White vs. Latinx-White disparities, reinforce the notion that this is a deep and complex systemic issue (Chantarat et al., 2021; Hardeman et al., 2022).

Finally, a previous study documented tremendous progress in health equity in the sharp reduction in homicides and in HIV/AIDS-related mortality in urban areas in the 1990s (Anderson and Zimmerman, 2021b). The sources of the drop in homicides are still a matter of debate, with reductions in antecedent childhood blood-lead levels one among several possible pathways (Nevin, 2007). The results in this study show the generalizability of this finding. Concentrated public-health efforts focused intensely on a known set of vectors of ill-health, coupled with urgent medical research and delivery, led to a considerable measure of success on what had once seemed an intractable problem. Hallmarks of this approach were a commitment to a public-health approach and sustained commitment to research and development of new medical therapies. Such sustained and highly focused commitment will again be required if the causes of health inequity are to be reversed.

The study produced some counterintuitive findings as well. Higher levels of county-level poverty are associated with lower mortality (Table 1, Model 1), as is a higher Latinx-White unemployment gap, meaning that, controlling for White unemployment, higher Latinx unemployment is associated with lower mortality. However, these results should be interpreted in light of the fact that education is also a covariate, and higher education has a much stronger (in terms of both magnitude and statistical significance) association with reduced mortality, as expected. In this context, the education variables are likely showing the strong protective effect of education and economic status generally for population-health outcomes, and the poverty or unemployment results must be seen as associations independent of education. Put differently, the results show that, for example, counties with high incomes *relative to low education* have higher than expected mortality. While this analysis did not explore these results in depth, it could be that boom counties, for example in the energy sector (fracking in North Dakota and Pennsylvania), or in counties with labor shortages in, for example, the meat packing, construction or personal services sectors, could be especially affected, as these jobs are also among the most hazardous. More research is needed to test whether this hypothesis is correct. In addition, research has shown that although economic status is positively associated with health generally, temporary boosts in income are associated with worse health, possibly because temporary income tends to be more likely to lead to unhealthy behaviors such as drinking (Granados, 2005).

4.4. Limitations

This study has certain limitations which bear mentioning. First, the analysis is associational in nature. Although the main specification applies county fixed-effects to control for time-invariant county-specific factors that may confound the relationships tested, this technique does not control for the possibility that poorer health may produce worse socioeconomic status. Second, the BRFSS study is not specifically designed to produce locally-representative estimates within states. We deal with this shortcoming by pooling multiple years together to smooth artificial variability that may result from oversampling in specific areas in any given year. Third, our decision to top-code healthy days may impact findings for that measure. However, since the percentage of respondents affected by this decision grew over the course of the study period (from 8.3% in 1994 to 12.8% in 2019), we believe this methodological decision would bias the trend results towards the null, and see no reason to suspect why this decision would impact certain counties more so than others for the regression analyses. Lastly, this is an ecological study, meaning the results may not correspond to risks for poor health at an individual level (Burgard et al., 2013).

5. Conclusion

Achieving health equity is a critical goal to public health. Reaching this goal is likely to require several sustained engagements.

First, scientists should continue to advance research in health equity as a distinct concept from health disparities. While there have been encouraging advances in this area (Hoyer et al., 2022; Liburd et al., 2020; Mandelbaum, 2020; Mays et al., 2021; van Raalte et al., 2018), there remains significant progress to be made. For instance, key funding mechanisms that play a critical role in supporting current and future

trends in research have sometimes lagged behind these developments in the literature. A recent study of NIH funding found that funding for training projects dedicated to health disparities was 14 times greater than that for health equity and social-determinants-of-health projects combined (Kneipp et al., 2018). For research projects, it was 19 times greater. Moreover, there was no trend over time in these ratios, suggesting that at least through 2016, the field was not changing to reflect evolving understanding of health equity. While it is possible that research not funded by the NIH is different, the authors conclude that, "a cadre of scientists … is poised to conduct health disparities research but may be less prepared to conduct research that targets health inequities and/or the SDOH [social determinants of health]."

Second, policy-makers will need to make a sustained commitment to prioritize policies and programs that are likeliest to move the needle on health equity. Because of the paucity of research on health equity, it is not yet clear what all of these policies might be, but the research here suggests that policies that broaden economic opportunity in society are likely to lead to substantial improvements in health equity. Such policies, while important everywhere, are particularly urgent in the nation's rural areas.

On the eve of the COVID-19 pandemic, trends for health equity were moving in a worrying direction in the United States. At the same time, solving these issues appears within our reach, but only if we are willing to commit to building a health and economic system that is more equitable and just.

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Ethical statement

Hereby, I, Nathaniel Anderson, consciously assure that for the manuscript "Trends and Structural Factors Affecting Health Equity in the United States at the Local Level, 1990–2019" the following is fulfilled:

1) This material is the authors' own original work, which has not been previously published elsewhere.
2) The paper is not currently being considered for publication elsewhere.
3) The paper reflects the authors' own research and analysis in a truthful and complete manner.
4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
5) The results are appropriately placed in the context of prior and existing research.
6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.
7) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

The violation of the Ethical Statement rules may result in severe consequences.

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I agree with the above statements and declare that this submission follows the policies of Solid State Ionics as outlined in the Guide for Authors and in the Ethical Statement.

CRediT authorship contribution statement

Nathaniel W. Anderson: Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Frederick J. Zimmerman:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

None.

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2024.101675.

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