Trends in Non-Hispanic White Mortality in the United States by Metropolitan-Nonmetropolitan Status and Region, 1990–2016

IRMA T. ELO
ARUN S. HENDI
JESSICA Y. HO
YANA C. VIERBOOM
SAMUEL H. PRESTON

The first decades of the twenty-first century have been a challenging period for American mortality. Life expectancy in the United States ranked 30th in the world in 2010 and is much lower than in other high-income countries (World Health Organization 2017). Between 2010 and 2016, US life expectancy fell further behind other developed countries, increasing by only 0.08 years, the smallest 5-year increase since 1970 (Ho and Hendi 2018). These relatively slow mortality declines occurred against a background in which US mortality in the 1990s and 2000s was already high by the standards of other OECD countries (Ho and Preston 2010; Crimmins et al. 2011; Ho 2013; Institute of Medicine and National Research Council 2013; Palloni and Yonker 2016). At the same time, there have been large and growing geographic and socioeconomic inequalities in health and mortality within the United States (Fenelon 2013; Wang et al. 2013; Hendi 2015, 2017; Chetty et al. 2016; Montez, Sasson, and Hayward 2016a).

Several recent studies of the national-level mortality stagnation have documented adverse mortality trends among middle-aged non-Hispanic whites (Kochanek, Arias, and Bastian 2016a; Squires and Blumenthal 2016; Case and Deaton 2017), particularly among women (Astone, Martin, and Aron 2015; Gelman and Auerbach 2016; Kochanek et al. 2016b) and those with lower levels of education (Hendi 2017) and income (Chetty et al. 2016). Case and Deaton (2015, 2017) drew attention to the role that “deaths of despair”—consisting of accidental poisoning (linked to the epidemic of prescription opioids and heroin), suicide, and chronic liver disease—play
in mortality increases among non-Hispanic whites. Elevated mortality from these causes of death is especially concentrated among individuals with low levels of education (see also Ho 2017; Kochanek et al. 2016b). However, these “deaths of despair” cannot fully explain the slowdown in mortality declines, since the adverse trends persist even after eliminating mortality from these causes (Squires and Blumenthal 2016; Monnat 2018; Rigg, Monnat, and Chavez 2018). Other causes of death are also hypothesized to be important contributors to stagnating mortality declines. Case and Deaton (2017) show that between 1999 and 2015, declines in cardiovascular disease and cancer mortality at ages 50–54 were relatively slow among non-Hispanic whites in the United States compared to other OECD countries. One study estimates that rising obesity has reduced the annual rate of decline in US death rates at ages 40–84 by 0.5–0.6 percentage points between 1986 and 2011 (Preston, Vierboom, and Stokes 2018).

A parallel literature has highlighted widening geographic inequalities in mortality in the period leading up to the recent mortality stagnation. Mortality improvements in Appalachia and the South, particularly the East South Central Division, have lagged behind other regions (Fenelon 2013; Wang et al. 2013), a pattern that has been partly linked to behavioral risk factors such as smoking and obesity (Fenelon 2013; Singh and Siahpush 2014; Dwyer-Lindgren et al. 2016; Dwyer-Lindgren et al. 2017; Mokdad et al. 2017; Roth et al. 2017). Trends in all-cause and cause-specific mortality rates have also varied considerably among US states (Chetty et al. 2016; Montez, Sasson, and Hayward 2016a) and counties (Ezzati et al. 2008; Dwyer-Lindgren et al. 2016; Roth et al. 2017). These studies typically find that although some counties, states, and regions have experienced improvements in life expectancy, others have experienced more moderate gains or even declines over the past few decades (Murray et al. 2006; Cullen, Cummins, and Fuchs 2012; Wang et al. 2013; Chetty et al. 2016).

Other studies have documented widening mortality differences between metropolitan and nonmetropolitan areas since the 1980s (Cosby et al. 2008; Cossman et al. 2010; James 2014; James and Cossman 2017; Moy et al. 2017). Singh and Siahpush (2014) examined data through 2009 and found that rural, nonmetropolitan areas made slower progress in life expectancy in the preceding decades than urban, metropolitan areas. More recently, Stein et al. (2017) focused on mortality trends at ages 25–64 between 1999 and 2015 by age, race/ethnicity, cause of death, and level of urbanization. They documented increasing death rates for non-Hispanic whites, mainly outside large urban areas, with suicide, poisoning, and liver disease contributing to these adverse trends. Death rates were the highest in rural areas for all racial/ethnic groups. Similarly, James and Cossman (2017) documented growing urban-rural disparities in age-adjusted mortality rates for both whites and Blacks since the mid-1980s. Percent poor, region, and emergency room visits and medical doctors per 1,000 were significant
predictors of age-adjusted death rates among whites in most metropolitan-nonmetropolitan subcategories in 2012, but not among Blacks, suggesting that factors that predict the metropolitan-nonmetropolitan mortality disparities vary by race/ethnicity.

In this article, we build on this prior research by providing a comprehensive examination of trends in non-Hispanic white mortality between 1990 and 2016 by metropolitan-nonmetropolitan status and region. Prior studies have often focused on finer levels of geographic variation, for example, counties or states, whereas our study examines 40 different geographic areas consisting of 10 broad geographic regions cross-classified by four metropolitan-nonmetropolitan categories. This cross-classification allows us to incorporate the substantial amount of variation within states (e.g., across metro-nonmetro categories) while identifying shared factors at the regional level that may be driving mortality trends. We focus on non-Hispanic whites because their mortality trends were particularly adverse in the last decade and differ from those of non-Hispanic Blacks and Hispanics. In contrast to non-Hispanic whites, mortality has continued to decline among Hispanics and non-Hispanic Blacks, although death rates remain substantially higher for Blacks than for whites (Harper, MacLehose, and Kaufman 2014; Murphy et al. 2017; Stein et al. 2017). The underlying mechanisms driving mortality trends for non-Hispanic whites are fundamentally different from those driving trends for other racial/ethnic groups, as suggested by James and Cossman (2017). Thus, we limit the scope of this article to non-Hispanic whites.

This article is an effort to unite the literature on adverse mortality trends among non-Hispanic whites at the national level with the literature on growing geographic inequalities in mortality. Our goals are to carefully document life expectancy trends in each of the 40 geographic areas described above, building upon previous research in several ways. First, we extend analyses to 2016 and include all age groups. Second, we estimate the contributions of four key age groups to changes in life expectancy at birth between 1990 and 2016 by metropolitan-nonmetropolitan status and region. Third, we examine the contribution of 14 broad, cause of death categories to these changes, highlighting categories that are strongly linked to behavioral factors and access to health care. In the Discussion section, we consider several potential explanations of the patterns we describe.

**Data and methods**

We use the 1990–2016 Multiple Cause of Death data files (provided by the National Center for Health Statistics under a data user agreement) to tabulate deaths by age, sex, race/ethnicity, cause of death, county, and year. To estimate person-years of exposure, we use the public-use Census bridged-race population estimates by age, sex, race/ethnicity, county, and
year. These data are combined to estimate age-specific death rates for all causes combined and for 14 specific, cause of death categories described below. Death rates are estimated for non-Hispanic white men and women by age, year, metropolitan-nonmetropolitan category, and geographic region. For parsimony, we use “white men” and “white women” to refer to non-Hispanic white men and non-Hispanic white women, respectively, from this point forward.

We focus on 14 mutually exclusive and exhaustive cause of death categories (described in Table A-1). Several of these categories are closely linked to behavioral factors: alcohol-attributable deaths and deaths from drug overdose, HIV/AIDS, homicide, suicide, lung cancer, respiratory diseases, and diabetes. Two categories, screenable cancers and influenza/pneumonia, were chosen as indicators of access to and quality of health services. Cardiovascular disease, which is the leading cause of death and influenced by both health behaviors and health care system variables, constitutes another category. We also consider the role of a composite category, “deaths of despair” (the aggregation of alcohol-attributable, drug overdose, and suicide mortality), which has been hypothesized to play a key role in adverse mortality trends among whites in recent years (Case and Deaton 2015, 2017; Ho 2017). In addition, we separate out mental and nervous system disorders, a category that includes Alzheimer’s disease and is of emerging importance (Xu et al. 2016; Ho and Hendi 2018). The remaining categories are the ill-defined causes category, which is used for nonspecific causes of death and accounts for a relatively small proportion of overall deaths, and the residual category.

To classify counties by metro-nonmetro status, we use the codes developed by the United States Department of Agriculture (USDA) Economic Research Service (ERS), which were modified and made available by the National Center for Health Statistics (https://www.cdc.gov/nchs/data_access/urban_rural.htm). We use four categories: large central metros, their suburbs (“large metro suburbs”), small/medium metros, and nonmetro areas (definitions of these categories are provided in Table 1). Results from preliminary investigations separating nonmetro counties by whether they were adjacent to metro areas were very similar for the two groups, so they were combined in the final analyses. To maintain consistency over time, we use the counties’ metropolitan category as of 2013 (preliminary analyses showed only minor differences if we used earlier classification schemes). Our 10 broad geographic regions are based on nine Census divisions and Appalachia, as defined by the Appalachian Regional Commission. Appalachia includes all of West Virginia and counties from 12 other states. The Appalachian counties are excluded from their overlapping Census divisions (definitions of these regions are provided in Table 1). When counties are cross-classified by region and metropolitan-nonmetropolitan category, we identify 40 distinct geographic units.
TABLE 1 Region and metropolitan-nonmetropolitan category classifications

| Region (State)          | Metropolitan-nonmetropolitan categories b |
|------------------------|------------------------------------------|
| 1. New England (CT, ME, MA, NH, RI, VT) | 1. Large central metro: Counties in MSAs of more than 1 million population, including counties that contain all or a part of the area’s inner cities |
| 2. Middle Atlantic (NJ, NY, PA)   | 2. Large metro suburb: Surrounding counties of the large central metros |
| 3. East North Central (IL, IN, MI, OH, WI) | 3. Small/medium metro: Counties in MSAs of 50,000–999,999 population |
| 4. West North Central (IA, KS, MN, MO, NE, ND, SD) | 4. Nonmetropolitan area (nonmetro): All other counties |
| 5. South Atlantic (DE, DC, FL, GA, MD, NC, SC, VA) | |
| 6. East South Central (AL, KY, MS, TN) | |
| 7. West South Central (AR, LA, OK, TX) | |
| 8. Mountain (AZ, CO, ID, MT, NV, NM, UT, WY) | |
| 9. Pacific (AK, CA, HI, OR, WA) | |
| 10. Appalachia a | |

MSA = metropolitan statistical area.

As defined by the Appalachian Regional Commission and includes all of WV and selected counties in AL, GA, KY, MD, MS, NY, NC, OH, PA, SC, TX, and VA. These counties are excluded from the remaining regions, which are based on the nine Census divisions.

bBased on USDA ERS and NCHS urban-rural classification scheme (Ingram and Franco 2014).

Our main measure of mortality is life expectancy at birth. We start by examining trends in life expectancy at birth and age-group contributions to changes in life expectancy across metro–nonmetro categories at the national level. Next, we investigate whether the metro-nonmetro mortality patterns observed at the national level also hold within regions. We focus on three periods (1990–1992, 2009–2011, and 2014–2016) and the change between 1990–1992 and 2014–2016 and between 2009–2011 and 2014–2016. Data are pooled across three-year periods to create more stable estimates. In estimating the life tables, \( n_a \) values are produced using graduation (Preston, Heuveline, and Guillot 2001). Mortality estimates for ages 85 and older are corrected using a variant of the procedure outlined in Horiuchi and Coale (1982) to account for differences across geographic areas in the age distributions of people aged 85 and older. The variant involves the use of a parametric smoothing procedure (as opposed to direct computation) to estimate growth rates and mortality above age 85.

Next, we estimate broad age group contributions (0–24, 25–44, 45–64, and 65+) to changes in life expectancy at birth using Arriaga’s (1984) decomposition. We focus on these four age groups because they are socially and economically meaningful: people aged 0–24 capture the young and school-aged population; people aged 25–44 have typically left school and
entered the workforce, and are not yet at the ages where chronic diseases dominate; people aged 45–64 are often labeled middle aged and, while still in the workforce, are more subject to chronic diseases; and people aged 65 and older are usually out of the workforce. In addition, the 45–64 age group overlaps with the age groups that were the focus of several prior studies of midlife mortality.

Third, we investigate the contribution of the specific cause of death categories described above to trends in life expectancy using Arriaga’s (1984) decomposition. We estimate these contributions for the four metro-nonmetro categories at the national level, and then for each of the 40 geographic areas (metro-nonmetro categories cross-classified with region). All analyses are performed separately by sex, and all decompositions sum to 100 percent of the change in life expectancy over time for a specific geographic area.

In the Discussion section, we introduce five variables that are potentially linked to the trends we observe and examine the correlation between trends in these variables and trends in life expectancy between 1990–1992 and 2014–2016 by the 40 region/metro-nonmetro categories. The five variables measure are as follows: educational attainment (percentage of college graduates from the 1990 US Census Summary files and 5-year 2011–2015 American Community Survey), physician availability (active, nonfederal physicians per 1,000 population from the Area Health Resource Files [US Health Resources & Services Administration 2018]), obesity (percentage of population aged 20 and older with body mass index greater than 30 kg/m² from the University of Wisconsin [2018]), transfer dependency (transfers as a percentage share of personal income from the Bureau of Economic Analysis 2018), and net in-migration rate for the working-age population (cumulative net in-migration rate for people aged 22.5–62.5, estimated using data from the NCHS and the Census Bureau and indirect methods detailed in the Appendix).³

Results

Trends by metro-nonmetro status

Table 2 presents changes in life expectancy between 1990 and 2016 by metro-nonmetro status. Life expectancy levels themselves are presented in Table A-2 in the Appendix. It is clear from Table 2 that the United States has experienced growing geographic inequality in life expectancy gains for white men and women over this period. This divergence has been driven by more rapid increases in life expectancy in large central metros and slower improvements elsewhere. White male life expectancy increased 5.09 years in large central metros, compared to 3.45 years in large metro suburbs, 2.81 years in small/medium metros, and 2.25 years in nonmetro
TABLE 2  Age group contributions (years) to changes in non-Hispanic white life expectancy at birth between 1990–1992 and 2014–2016 and between 2009–2011 and 2014–2016 by metropolitan-nonmetropolitan category and sex

|                | (1990–1992) to (2014–2016) |         |         |         |         |
|----------------|-----------------------------|---------|---------|---------|---------|
| Alpha (Δe0)   | 0–24 years                  | 25–44 years | 45–64 years | 65+ years |
| Males         |                             |         |         |         |         |
| Large central metro | 5.09                    | 0.57    | 0.83    | 1.23    | 2.46    |
| Large metro suburb | 3.45                    | 0.41    | −0.18   | 0.85    | 2.37    |
| Small/medium metro | 2.81                    | 0.46    | −0.20   | 0.42    | 2.14    |
| Nonmetro      | 2.25                        | 0.53    | −0.31   | 0.26    | 1.77    |
| Females       |                             |         |         |         |         |
| Large central metro | 2.98                    | 0.37    | 0.03    | 0.68    | 1.91    |
| Large metro suburb | 2.23                    | 0.26    | −0.21   | 0.52    | 1.65    |
| Small/medium metro | 1.24                    | 0.25    | −0.31   | 0.08    | 1.22    |
| Nonmetro      | 0.20                        | 0.24    | −0.46   | −0.21   | 0.63    |
| (2009–2011) to (2014–2016) |         |         |         |         |         |
|                |                             |         |         |         |         |
| Males         |                             |         |         |         |         |
| Large central metro | 0.31                    | 0.07    | −0.13   | 0.08    | 0.29    |
| Large metro suburb | 0.05                    | 0.03    | −0.29   | −0.01   | 0.32    |
| Small/medium metro | −0.11                   | 0.02    | −0.20   | −0.17   | 0.24    |
| Nonmetro      | −0.18                       | 0.06    | −0.16   | −0.22   | 0.14    |
| Females       |                             |         |         |         |         |
| Large central metro | 0.36                    | 0.04    | −0.05   | 0.03    | 0.35    |
| Large metro suburb | 0.20                    | 0.02    | −0.14   | −0.01   | 0.32    |
| Small/medium metro | −0.06                   | 0.01    | −0.13   | −0.18   | 0.23    |
| Nonmetro      | −0.29                       | 0.03    | −0.14   | −0.25   | 0.08    |

NOTE: Numbers may not add up due to rounding.
SOURCE: Vital Statistics and Census Data. Calculations by the authors.

areas. Large central metros are now among the areas with the highest white male life expectancy in the country. This ascendance is particularly noteworthy because large central metros had the lowest life expectancy levels in 1990–1992. The gain in large central metros was 2.3 times greater (5.09/2.25) than that in nonmetro areas, which had the second lowest life expectancy levels in 1990–1992.

Among white women, life expectancy differences by metro-nonmetro status were relatively small in 1990–1992. However, by 2014–2016, substantial variation emerged, with the largest gains recorded in large central metros (2.98 years), followed by large metro suburbs (2.23 years), small/medium metros (1.24 years), and nonmetro areas (0.20 years) (Table 2). These differences are particularly striking for large central metros compared to nonmetros, with gains in white female life expectancy that were 14.9 times greater (2.98/0.20) in large central metros than in nonmetro areas.

The most recent period stands out for its stark metro-nonmetro differences (Table 2, bottom panel). Between 2009–2011 and 2014–2016, large
central metros and large metro suburbs continued to experience gains in life expectancy, but small/medium metros and nonmetros experienced life expectancy declines. Thus, while the metro-nonmetro gradient widened between 1990–1992 and 2009–2011 due to quicker gains among large central metros, the gradient has since widened due to a combination of gains in large metros and their suburbs and declines in small/medium metros and nonmetro areas.

The pattern of life expectancy gains was similar for men and women, but women experienced smaller gains than men, leading to a narrowing of sex differences in life expectancy. By 2014–2016, the sex difference ranged from 4.65 years in large metro suburbs to 4.96 in nonmetro areas, down from 5.87 years in large metro suburbs and 7.01 years in nonmetro areas in 1990–1992 (Table A-2).

There are important variations in the contribution of different age groups to life expectancy trends across the metro-nonmetro categories. In large central metros, all age groups contributed to gains in life expectancy between 1990 and 2016 (Table 2, top panel). In the other three areas, however, mortality increased at ages 25–44 for both white men and women and additionally at ages 45–64 for white women in nonmetro areas. Between 2009–2011 and 2014–2016, mortality increased in the 25–44 age group for white men and women in all four categories, including large central metros. Furthermore, in all areas except large central metros, mortality increased at ages 45–64 (Table 2, bottom panel).

Trends by metro-nonmetro status and region

The national trends in life expectancy by metro-nonmetro status are also observed within most regions of the country, with important regional variation. Figure 1 and Table 3 present trends in life expectancy between 1990–1992 and 2014–2016 for the 40 areas, representing the four metro-nonmetro categories and the 10 geographic regions. Life expectancy levels by metro-nometro areas and region are shown in Table A-3 in the Appendix. The spatial pattern that was evident for the nation as a whole in Table 2—greatest life expectancy gains in large central metros and smallest life expectancy gains in nonmetros—is, with minor exceptions, maintained within each of the 10 regions. At the same time, regional variations are also evident: the Middle Atlantic and Pacific regions stand out as having particularly rapid life expectancy gains for white men in large central metros, on the order of 7.13 and 6.11 years, respectively. White men in nonmetro areas of the Appalachian, East South Central, and West South Central regions experienced the smallest gains, amounting to 1.42–1.80 years.

A similar pattern is observed for white women, with the largest gains occurring in large central metros in the Middle Atlantic (4.66 years) and Pacific (4.00 years) regions. Nonmetro areas experienced the smallest gains
FIGURE 1  Change in non-Hispanic white life expectancy at birth (in years) by metropolitan-nonmetropolitan category and region, 1990–1992 and 2014–2016

NOTE: APP = Appalachia, ENC = East North Central, ESC = East South Central, MA = Middle Atlantic, MTN = Mountain, NE = New England, PAC = Pacific, SA = South Atlantic, WNC = West North Central, WSC = West South Central.
|                | Large central metro | Large metro suburb | Small/medium metro | Nonmetro |
|----------------|---------------------|--------------------|--------------------|----------|
| **Males**      |                     |                    |                    |          |
| APP            | 2.54                | 0.24               | -0.43              | 0.51     |
| ENC            | 3.86                | 0.50               | 0.13               | 0.92     |
| MA             | 7.13                | 0.76               | 1.65               | 1.98     |
| MTN            | 4.03                | 0.64               | 0.52               | 0.79     |
| NE             | 4.23                | 0.45               | 0.45               | 1.01     |
| PAC            | 6.11                | 0.67               | 1.33               | 1.47     |
| SA             | 5.34                | 0.61               | 0.92               | 1.42     |
| WNC            | 4.79                | 0.57               | 0.56               | 1.07     |
| WSC            | 4.58                | 0.49               | 0.81               | 1.02     |
| **Females**    |                     |                    |                    |          |
| APP            | 1.55                | 0.09               | -0.39              | 0.28     |
| ENC            | 2.20                | 0.29               | -0.15              | 0.55     |
| MA             | 4.66                | 0.58               | 0.46               | 1.15     |
| MTN            | 1.99                | -0.15              | 0.30               | 1.53     |
| NE             | 2.32                | 0.19               | -0.03              | 0.54     |
| PAC            | 4.00                | 0.48               | 0.20               | 0.94     |
| SA             | 2.93                | 0.43               | 0.02               | 0.66     |
| WNC            | 2.32                | 0.31               | -0.02              | 0.59     |
| WSC            | 2.20                | 0.26               | -0.06              | 0.44     |

- **APP** = Appalachia, **ENC** = East South Central, **ESC** = East South Central, **MA** = Middle Atlantic, **MTN** = Mountain, **NE** = New England, **PAC** = Pacific, **SA** = South Atlantic, **WNC** = West North Central, **WSC** = West South Central.
- **NOTE:** Numbers may not add up due to rounding.
- **SOURCE:** Vital Statistics and Census Data. Calculations by the authors.
in female life expectancy, especially in the East North Central, West North Central, and South Atlantic regions, with actual declines in life expectancy observed in nonmetro areas of the Appalachian, East South Central, and West South Central regions.

In all 40 areas, white men’s life expectancy gains outpaced white women’s life expectancy gains. If we compare the best-performing region/metro category/sex combination to the worst-performing combination, men in large central metros in the Middle Atlantic gained 7.13 years of life expectancy during this period whereas women in nonmetros in the West South Central and East South Central regions lost nearly a year in life expectancy between 1990–1992 and 2014–2016.

Despite the strong performance of large central metros and the relatively poor performance of nonmetros within each region, striking patterns emerge when comparing across both region and metro category. For example, large central metros outperformed nonmetros within the Appalachian and East South Central regions. However, life expectancy gains in large central metros in these two regions were significantly smaller than gains in nonmetros of the Middle Atlantic. The life expectancy gains in nonmetros of the Middle Atlantic exceeded those in large central metros of the Appalachian and East South Central regions by 1.2–1.3 years for men and 0.5–1.2 years for women.

Age-specific contributions to gains in life expectancy between 1990–1992 and 2014–2016 by metro-nonmetro status and region are shown in Figures 2A and 2B and Table 3. Again, the patterns observed for the nation as a whole are repeated in many of the 40 areas. Mortality increases among white men and women aged 25–44 were widespread in large metro suburbs, small/medium metros, and nonmetro areas, with the most noticeable increases typically occurring in Appalachia and New England. Mortality improvements at ages 65 and above made the largest contributions to gains in life expectancy in all 40 geographic areas.

When we consider life expectancy trends between 2009–2011 and 2014–2016 (Table 4 and Figures 3A and 3B), the adverse mortality trends in the 25–44 age group are even more striking. In all four metro categories and across almost every region, mortality at ages 25–44 contributed negatively to life expectancy trends in this most recent period. These contributions were particularly large in the New England and Appalachian regions for both men and women. Ages 45–64 also contributed negatively to life expectancy trends in many areas, and more so among women than among men. We observed a metro-nonmetro gradient with respect to these age contributions: mortality at ages 25–44 mattered relatively more in large central metros and their suburbs, while mortality at ages 45–64 contributed relatively more to negative trends in small/medium metros and nonmetros.

These adverse mortality trends among working-aged whites led to declines in life expectancy at birth between 2009–2011 and 2014–2016 for
FIGURE 2A  Age-group contributions (in years) to changes in non-Hispanic white male life expectancy at birth by metropolitan-nonmetropolitan category and region, 1990–1992 to 2014–2016

NOTE: APP = Appalachia, ENC = East North Central, ESC = East South Central, MA = Middle Atlantic, MNT = Mountain, NE = New England, PAC = Pacific, SA = South Atlantic, WNC = West North Central, WSC = West South Central.
FIGURE 2B  Age-group contributions (in years) to changes in non-Hispanic white female life expectancy at birth by metropolitan-nonmetropolitan category and region, 1990–1992 to 2014–2016

NOTE: APP = Appalachia, ENC = East North Central, ESC = East South Central, MA = Middle Atlantic, MTN = Mountain, NE = New England, PAC = Pacific, SA = South Atlantic, WNC = West North Central, WSC = West South Central.
### TABLE 4  Age group contributions (in years) to changes in non-Hispanic white life expectancy at birth between 2009–2011 and 2014–2016 by metropolitan-nonmetropolitan category, region, and sex

| Region          | Large central metro | Large metro suburb | Small/medium metro | Nonmetro |
|-----------------|---------------------|--------------------|--------------------|----------|
|                 | Δ e0 0–24 25–44 45–64 65+ | Δ e0 0–24 25–44 45–64 65+ | Δ e0 0–24 25–44 45–64 65+ | Δ e0 0–24 25–44 45–64 65+ |
| **Males** APP   | −0.17 0.01 −0.45 0.30 | −0.22 −0.04 −0.47 0.34 | −0.23 0.02 −0.26 0.20 | −0.18 0.04 −0.14 −0.27 0.19 |
| ENC             | 0.00 0.05 −0.25 0.01 | 0.04 0.07 −0.31 0.01 | 0.21 −0.35 −0.01 −0.34 | −0.15 0.15 | −0.27 0.03 −0.27 −0.15 0.12 |
| ESC             | −0.50 −0.02 −0.31 0.07 | −0.10 0.05 −0.25 −0.16 | 0.27 −0.32 −0.05 −0.20 | −0.26 0.19 | −0.42 0.02 −0.18 −0.29 0.03 |
| MA              | 0.36 0.01 −0.19 0.22 | 0.31 0.04 −0.38 0.04 | 0.35 −0.22 0.01 −0.30 | −0.11 0.18 | 0.23 0.25 −0.23 −0.16 0.37 |
| MTN             | 0.29 0.14 −0.09 0.01 | 0.23 −0.10 −0.14 0.03 | 0.45 −0.03 0.02 −0.14 | −0.19 0.29 | 0.00 0.13 −0.24 −0.13 0.24 |
| NE              | 0.00 0.05 −0.40 0.11 | 0.24 −0.50 −0.04 −0.67 | −0.08 0.28 −0.61 −0.06 | 0.57 −0.14 | −0.41 0.06 −0.52 −0.22 0.26 |
| PAC             | 0.53 0.08 −0.03 0.16 | 0.33 0.09 −0.07 0.03 | 0.25 0.08 0.06 −0.03 | −0.20 0.25 | −0.28 −0.15 −0.10 −0.20 0.17 |
| SA              | 0.57 0.05 −0.07 0.13 | 0.46 0.08 0.04 −0.28 | −0.06 0.37 0.10 0.06 | −0.18 −0.13 0.35 −0.17 0.02 | −0.14 −0.25 0.20 |
| WNC             | 0.57 0.13 0.00 0.24 | 0.33 0.36 0.05 −0.15 | 0.08 0.38 0.04 0.05 | −0.09 −0.13 0.21 −0.11 0.09 | −0.08 −0.22 0.10 |
| WSC             | 0.30 0.13 −0.07 0.01 | 0.23 0.41 0.04 −0.09 | 0.05 0.41 −0.01 0.07 | −0.02 −0.20 0.14 −0.10 0.14 | 0.03 −0.28 0.02 |
| **Females** APP | −0.05 0.00 −0.22 0.12 | 0.28 −0.08 0.02 −0.26 | −0.12 0.28 −0.30 0.05 | −0.18 −0.27 0.10 | −0.29 0.07 −0.16 −0.31 0.11 |
| ENC             | 0.05 0.08 −0.15 0.02 | 0.14 0.20 0.05 −0.14 | 0.00 0.28 −0.32 −0.01 | −0.22 −0.18 0.09 | −0.27 0.07 −0.15 −0.16 −0.03 |
| ESC             | −0.41 −0.02 −0.35 0.18 | −0.14 0.20 −0.02 −0.14 | −0.15 0.11 −0.03 0.07 | 0.00 −0.27 0.18 | −0.46 0.07 −0.15 −0.37 0.00 |
| MA              | 0.41 0.02 −0.03 0.13 | 0.28 0.26 0.01 −0.16 | 0.07 0.33 0.05 0.03 | −0.19 −0.09 0.30 | 0.23 0.10 −0.08 −0.09 0.29 |
| MTN             | 0.33 0.02 −0.06 0.05 | 0.43 0.69 0.14 −0.05 | 0.18 0.42 −0.01 0.00 | −0.08 −0.20 0.26 | 0.12 0.02 −0.05 0.16 0.31 |
| NE              | 0.08 −0.02 −0.02 0.05 | 0.16 0.04 0.04 −0.25 | −0.04 0.29 −0.16 −0.03 | −0.25 0.00 0.12 | −0.32 −0.09 −0.25 −0.14 0.15 |
| PAC             | 0.63 0.06 0.01 0.11 | 0.45 0.39 0.02 −0.04 | 0.03 0.38 0.24 0.00 | 0.02 −0.07 0.30 | −0.02 −0.07 −0.13 −0.31 0.49 |
| SA              | 0.65 0.03 −0.03 0.06 | 0.59 0.20 0.00 −0.15 | −0.03 0.38 0.03 0.03 | −0.13 −0.25 0.38 | −0.38 −0.08 −0.17 −0.30 0.17 |
| WNC             | 0.47 0.03 0.01 0.08 | 0.34 0.23 0.01 −0.12 | 0.05 0.30 0.08 −0.03 | −0.03 −0.09 0.22 | −0.38 0.04 −0.09 −0.23 −0.11 |
| WSC             | 0.44 0.07 0.02 0.03 | 0.38 0.26 0.04 −0.06 | 0.11 0.39 −0.11 0.05 | −0.11 −0.24 0.18 | −0.45 0.00 −0.14 −0.34 0.03 |

**NOTE:** Numbers may not add up due to rounding.

**SOURCE:** Vital Statistics and Census Data. Calculations by the authors.
FIGURE 3A  Age-group contributions (in years) to changes in non-Hispanic white male life expectancy at birth by metropolitan-nonmetropolitan category and region, 2009–2011 to 2014–2016

NOTE: APP = Appalachia, ENC = East North Central, ESC = East South Central, MA = Middle Atlantic, MTN = Mountain, NE = New England, PAC = Pacific, SA = South Atlantic, WNC = West North Central, WSC = West South Central.
FIGURE 3B  Age-group contributions (in years) to changes in non-Hispanic white female life expectancy at birth by metropolitan-nonmetropolitan category and region, 2009–2011 to 2014–2016

NOTE: APP = Appalachia, ENC = East North Central, ESC = East South Central, MA = Middle Atlantic, MTN = Mountain, NE = New England, PAC = Pacific, SA = South Atlantic, WNC = West North Central, WSC = West South Central.
both sexes in all nonmetro areas except in the Middle Atlantic and Mountain regions. Among men, life expectancy also declined in small/medium metros in seven out of 10 regions, in large metro suburbs in four out of 10 regions, and in large central metros in two out of 10 regions. Women experienced life expectancy declines in small/medium metros in six regions, in large metro suburbs in two regions, and in large central metros in two regions. The setbacks suffered by working-aged whites during this most recent period were clearly widespread by sex, region, and metropolitan category, but the most severe problems were encountered in nonmetropolitan areas.

Cause-specific contributions to trends by metro-nonmetro status

Table 5 and Figure 4 present cause of death contributions to the change in life expectancy by metro-nonmetro status between 1990 and 2016. Causes of death with positive values in Table 5 contribute to life expectancy improvements, while those with negative values contribute to life expectancy reductions. In all four areas, reductions in cardiovascular disease mortality made the largest contributions to improvements in life expectancy. Mortality from causes of death amenable to health care, such as screenable cancers, influenza and pneumonia, and HIV/AIDS, also contributed to life expectancy gains in all four metro-nonmetro categories, but these contributions were the smallest in nonmetro areas. Reductions in mortality from HIV/AIDS (likely related to the introduction of highly active antiretroviral therapy) were more important for men than for women, and their impact was particularly large for men in large central metros, where it made the second largest contribution to life expectancy gains, after cardiovascular disease (Chiasson et al. 1999; Messeri et al. 2003).

Among causes of death closely tied to health behaviors, declining lung cancer mortality made important contributions to life expectancy increases among men, but much smaller contributions among women. For women in nonmetro areas, lung cancer mortality increased over time. Mortality from respiratory diseases, which are also related to smoking, increased among women, with the largest increases recorded in nonmetro areas.

Mortality from drug overdose, suicide, and alcohol-related causes of death, which largely comprise “deaths of despair” category, increased and contributed to life expectancy reductions across the metro-nonmetro categories. Drug overdose was the most important contributor among these causes, and it made a larger contribution to life expectancy declines among men than women. Among men, drug overdose made the largest impact in large metro suburbs, followed by small/medium metros, nonmetros, and large central metros. Among women, the impacts were greater in large metro suburbs, small/medium metros, and nonmetros than in large central metros. Alcohol-related causes were a minor factor in all metro categories.
# TABLE 5 Cause-specific contributions (in years) to changes in non-Hispanic white life expectancy at birth between 1990–1992 and 2014–2016 by metropolitan-nonmetropolitan category and sex

| Cause of death               | Large central metro | Large metro suburb | Small/medium metro | Nonmetro |
|------------------------------|---------------------|--------------------|--------------------|----------|
| **Males**                    |                     |                    |                    |          |
| HIV/AIDS                     | 0.86                | 0.27               | 0.19               | 0.09     |
| Homicide                     | 0.24                | 0.06               | 0.03               | 0.04     |
| Alcohol-related causes       | −0.01               | −0.06              | −0.10              | −0.07    |
| Drug overdose                | −0.46               | −0.71              | −0.57              | −0.47    |
| Suicide                      | 0.01                | −0.09              | −0.12              | −0.14    |
| Screenable cancers<sup>a</sup> | 0.32                | 0.36               | 0.30               | 0.24     |
| Lung cancer                  | 0.64                | 0.61               | 0.58               | 0.48     |
| Respiratory disease          | 0.14                | 0.06               | 0.04               | −0.05    |
| Circulatory disease          | 2.59                | 2.53               | 2.31               | 2.09     |
| Mental and nervous system disorders<sup>b</sup> | −0.35               | −0.41              | −0.41              | −0.37    |
| Diabetes                     | −0.04               | −0.02              | −0.07              | −0.11    |
| Influenza/pneumonia          | 0.25                | 0.21               | 0.21               | 0.19     |
| Symptoms and ill-defined     | 0.10                | 0.06               | 0.07               | 0.05     |
| All other                    | 0.82                | 0.59               | 0.35               | 0.30     |
| All causes combined          | 5.09                | 3.45               | 2.81               | 2.25     |
| **Females**                  |                     |                    |                    |          |
| HIV/AIDS                     | 0.07                | 0.03               | 0.01               | 0.00     |
| Homicide                     | 0.06                | 0.02               | 0.02               | 0.01     |
| Alcohol-related causes       | −0.04               | −0.05              | −0.08              | −0.07    |
| Drug overdose                | −0.26               | −0.36              | −0.36              | −0.35    |
| Suicide                      | −0.02               | −0.06              | −0.08              | −0.09    |
| Screenable cancers<sup>a</sup> | 0.47                | 0.49               | 0.39               | 0.32     |
| Lung cancer                  | 0.26                | 0.18               | 0.09               | −0.05    |
| Respiratory disease          | −0.09               | −0.20              | −0.28              | −0.47    |
| Circulatory disease          | 2.58                | 2.37               | 2.14               | 1.84     |
| Mental and nervous system disorders<sup>b</sup> | −0.88               | −0.91              | −0.97              | −0.94    |
| Diabetes                     | 0.03                | 0.07               | 0.03               | 0.00     |
| Influenza/pneumonia          | 0.28                | 0.24               | 0.22               | 0.18     |
| Symptoms and ill-defined     | 0.02                | 0.00               | 0.01               | −0.02    |
| All other causes             | 0.52                | 0.40               | 0.09               | −0.15    |
| All causes combined          | 2.98                | 2.22               | 1.24               | 0.20     |

<sup>a</sup>Breast, prostate, colorectal, and cervical cancer.
<sup>b</sup>Includes Alzheimer’s disease.

**NOTE:** Negative values indicate contributions to reductions in life expectancy and positive values indicate contributions to increases in life expectancy between 1990–1992 and 2014–2016.

**SOURCE:** Vital Statistics and Census Data. Calculations by the authors.
One of the most important contributors to life expectancy reductions were mental and nervous system disorders, including Alzheimer’s disease. This category was particularly important for women, making large negative contributions to life expectancy trends in all metro-nonmetro areas.

Cause-specific contributions to trends by metro-nonmetro status and region

The basic pattern of cause-specific contributions across the metro-nonmetro continuum at the national level is preserved across regions (Figures 5A and 5B), with a few key variations. In all 40 areas, reductions in cardiovascular disease mortality made the largest contribution to increases in life expectancy at birth. This was observed for both men and women. Declines in lung cancer mortality were evident in all regions and all metro-nonmetro categories among men, but were small or absent among women, especially in nonmetro areas. One exception is the Pacific region, where women did experience reductions in lung cancer mortality in all metro-nonmetro categories. As was the case nationally, increases in respiratory disease mortality contributed to life expectancy reductions among women in all regions, with the largest impact generally observed in nonmetro areas. Increases in
respiratory disease mortality were particularly large among women in non-metro areas of the Appalachian, East South Central, West South Central, West North Central, and South Atlantic regions, where they contributed to a roughly 0.5-year reduction in life expectancy at birth.

Across both region and metro-nonmetro categories, the contributions of causes of death related to medical care (e.g., screenable cancers, HIV/AIDS, and influenza/pneumonia) were similar to those documented for the country as a whole. In all regions, these causes contributed to an increase in life expectancy. The contribution of HIV/AIDS was particularly large in large central metros in the Middle Atlantic (1.45 years), South Atlantic (0.94 years), and Pacific (1.12 years) regions among men, whereas among women, HIV/AIDS made a sizeable contribution only in large central metros of the Middle Atlantic (0.30 years). Screenable cancers and influenza and pneumonia generally made larger contributions to life expectancy improvements among women than among men.

Furthermore, the cause of death categories contributing to adverse life expectancy trends in Table 5 and Figure 1 are also implicated in adverse life expectancy trends in all regions across metro-nonmetro categories. There is some evidence, especially among men, that suicide tends
to make larger contributions to life expectancy reductions in nonmetros and small/medium metros than in large central metros and their suburbs. Drug overdose is a key contributor to life expectancy reductions for men in all 40 areas, making the largest contributions in Appalachia and New England and the smallest contribution in the Pacific. In most regions, there is no clear gradient in the contribution of drug overdose to life expectancy reductions by metro-nonmetro category. However, there are two exceptions: in Appalachia, there is a positive relationship between this contribution and the level of urbanicity (i.e., drug overdose makes the largest contribution to life expectancy reductions in large central metros and the smallest contribution in nonmetros), and in the Pacific, a negative relationship holds. Among women, drug overdose made important contributions in the Appalachian and East South Central regions. Thus, the patterns of cause of death contributions are surprisingly similar across the country with some variation in the magnitudes of their impact.

Summary and discussion

Over the last quarter century, we have witnessed growing geographic inequalities in mortality in the United States. Two notable features of the last
25 years are the sizable increase in life expectancy in large central metros and the slow improvement or decline, especially among women, in non-metro areas. For the United States as a whole, white male life expectancy at birth in large central metros increased by 5.09 years between 1990–1992 and 2014–2016; the comparable figure for white women was 2.98 years. In contrast, nonmetro areas experienced the smallest life expectancy gains: 2.25 years among white men and only 0.20 years among white women. This pattern of larger increases in life expectancy in large central metros and small or negligible increases or even declines in nonmetro areas was pervasive in all 10 regions of the country examined in these analyses.

**Importance of mortality trends at the working ages**

The extant literature has largely focused on adverse trends among middle-aged whites, especially at ages 45–54 (Case and Deaton 2015, 2017). Our study demonstrates that adverse mortality trends in a younger age group, ages 25–44, also slowed life expectancy improvements in large metro suburbs, small/medium metros, and nonmetro areas between 1990–1992 and 2014–2016. Since 2010, mortality increased at ages 25–44 in all metro-nonmetro categories and at ages 45–64. The mortality increases at younger ages are particularly troubling. The causes of death that predominate at these ages, like drug overdose, are largely preventable and may be related to worsening social and economic conditions. Young adults today have experienced difficulties coming of age during the Great Recession, that is, delayed transition to adulthood, declines in marriage, and increased rates of coresidence with parents. An indicator of the poor economic conditions among these cohorts is that 41 percent of men aged 25–34 earned less than $30,000 per year in 2016; this figure was only 25 percent in 1975 (Vespa 2017). A recent study documented large increases in mortality from alcoholic liver cirrhosis among adults aged 25–34 (Tapper and Parikh 2018). Furthermore, the adverse mortality conditions and the underlying factors driving these trends may have life course implications. For example, adults in this age group have increased rates of drug and alcohol abuse and may experience increased morbidity and mortality related to these behaviors in future decades (Corrao et al. 2004; Ronan and Herzig 2016; Ho 2019).

Another surprising new finding from our study is that adverse mortality changes in the recent period were greater at ages 25–44 than at ages 45–64 in large metros and their suburbs, whereas adverse mortality changes at ages 45–64 were generally greater than those at ages 25–44 in small/medium metros and nonmetros. These results suggest that there are distinct underlying mechanisms driving negative trends in large metro areas, where younger adults appear to be more vulnerable, and in small/medium metros and nonmetros, where middle-aged adults appear to be more vulnerable. In addition, we find that mortality increases in the
recent period at the younger working ages (25–44) are greater for males than females in all residential categories, whereas there is little sex difference in trends at ages 45–64. This pattern is potentially related to the younger age profile of drug overdose mortality for men relative to women (Ho 2019).

Deaths of despair and neurological disorders

Prior studies have documented adverse trends in mortality related to poisonings, liver cirrhosis, and suicide within particular age groups (Case and Deaton 2015, 2017; Stein et al. 2017). We find that among these causes, drug overdose makes the largest contribution to trends in life expectancy between 1990–1992 and 2014–2016 in all metro categories and all regions. Its contribution was not limited to only nonmetros or to Appalachia. The impact of drug overdose has been greatest in large metro suburbs for men and additionally in small/medium metros and nonmetros for women. We also find that regions have been differentially impacted: drug overdose had the largest impact on trends in the Appalachian, East South Central, and New England regions and the smallest impact in the Pacific region.

In addition to drug overdoses, mental and nervous system disorders—including Alzheimer’s disease—have made negative contributions to trends in life expectancy between 1990–1992 and 2014–2016, particularly among women. Included among mental and nervous system disorders are those associated with substance abuse (e.g., opioids, alcohol, cocaine, and other substances), as well as psychological disorders such as depression and anxiety disorders. The overall geographic pattern of the contribution of mental disorders is similar to the pattern for drug overdose mortality, and many of these deaths may also be associated with the recent opioid epidemic. For example, both mental disorders and drug overdose made large contributions to reductions in life expectancy in large metro suburbs in New England between 1990–1992 and 2014–2016. In the region/metro-nonmetro combinations where the contribution of mental disorders was high, the contribution of Alzheimer’s disease tended to be smaller. These patterns may, in part, reflect regional differences in coding practices over time and substitution between cause of death categories (Taylor et al. 2017). The increase in death rates from mental and neurological disorders, including Alzheimer’s disease, is not unique to the United States, and has also been observed in several European countries (Mackenbach, Karanikolos, and Looman 2014; Ho and Hendi 2018).

Smoking

If drug overdoses and mental and neurological disorders do not explain the widening mortality gap between metro-nonmetro categories across all
regions, what other causes or conditions might help explain these growing disparities? Studies estimating the impact of smoking on state-level and regional differences in mortality indicate that health behaviors likely play an important role. Fenelon and Preston (2012) estimated that in 2004, the fraction of deaths attributable to smoking at ages 50 and older in US states ranged from 11 to 30 percent among men and from 7 to 23 percent among women. Smoking has also been identified as an important contributor to the low US life expectancy ranking among developed countries (Preston, Glei, and Wilmoth 2010) and at least some of the poor US performance internationally is likely related to the geographic variation in smoking-related mortality within the United States. Between 1965 and 2004, smoking explained a large fraction (up to 70 percent) of the growing gap in male mortality between the worst-performing Census division, East South Central, and other Census divisions, and around 50 percent of the growing gap in female mortality (Fenelon 2013). Given the higher prevalence of smoking in nonmetro areas, we anticipated that smoking would account for a sizable fraction of the growing metro-nonmetro gap in life expectancy (Fenelon and Preston 2012; Fenelon 2013; Roberts et al. 2016).

The two causes of death most closely tied to smoking are lung cancer and respiratory diseases. Together, these causes accounted for 0.78 year of the 5.09-year gain in life expectancy among white men in large central metros compared to 0.43 years of the 2.25-year gain in nonmetro areas, resulting in a difference of 0.35 year between these two areas (Table 5). This same pattern was the most evident in the midwestern states, the South, and Appalachia. Among white women, these two smoking-related causes made a smaller contribution to the increase in life expectancy in large central metros (0.17 year) and contributed to life expectancy reductions in large metro suburbs (−0.02 year), small/medium metros (−0.19 year), and nonmetro areas (−0.52 year). These patterns were evident among women in most regions. Thus, smoking-related causes likely played a key role in the widening of metro-nonmetro inequalities in life expectancy at birth, especially among women (Preston and Wang 2006).

Obesity

A number of studies have documented that sedentary lifestyle, poor diet, and obesity are more common in nonmetro than in metro areas (Eberhardt and Pamuk 2004; Michimi and Wimberly 2010; Befort, Nazir, and Perri, 2012; Meit et al. 2014; Wen et al. 2018). Diabetes is the cause of death most closely tied to obesity. Trends in diabetes mortality make a small impact on the trends that we observe, but this may be a result of underreporting of diabetes on death certificates (Saydah et al. 2004). In contrast, cardiovascular disease, which is tied to both health behaviors such as obesity and smoking as well as to medical care (Ford et al. 2007), was the cause of death
responsible for the largest improvements in life expectancy in all areas and for most of the variation in life expectancy trends across the 40 geographic areas between 1990–1992 and 2014–2016.

In Figures 6A and 6B, the change in life expectancy between 1990–1992 and 2014–2016 is graphed against the change in percent obese between 2004 and 2013 in our 40 areas. The correlation between increases in life expectancy and change in percent obese is –0.74 for both men and women. These figures suggest that obesity, a risk factor for cardiovascular and other chronic diseases, quite possibly plays some role in the trends we observe. Changes in obesity prevalence have greater correlation with geographic changes in life expectancy than any other variable that we examine.

Health care

Other causes of death influenced by access to and quality of health care include screenable cancers, influenza and pneumonia, and HIV/AIDS. These causes made larger contributions to life expectancy increases in large central metros than in nonmetro areas. This was especially true for HIV/AIDS among white men, which is partly attributable to the fact that this cause of death was much more prevalent in large central metros than in nonmetros. HIV/AIDS made the largest contribution to life expectancy improvements among men in large central metros in the Middle Atlantic, South Atlantic, and Pacific regions.

Historically, nonmetro areas have suffered from shortages of both health care personnel and facilities (Rosenblatt and Hart 2000). These shortages stem from rural areas’ difficulty in recruiting and retaining high-quality medical personnel due to lower wages, remoteness, greater population dispersion, poverty, and economic instability (Rosenblatt 2004; Rosenblatt et al. 2006; Burrows, Ryung, and Hamann 2012). Rural and urban areas also differ in terms of specialty mix: generalists provide much of the care in rural areas, whereas specialty care dominates in urban areas (Rosenblatt 2004; Reschosky and Staiti 2005). Shortages of mental health care facilities, substance abuse treatment, and pharmaceutical services are particularly acute in rural areas, and may be one factor contributing to the trends in mortality from drug overdose and mental disorders discussed above (Reschosky and Staiti 2005; Burrows, Ryung, and Hamann 2012). Finally, rural residents face greater transportation barriers and may have to travel great distances or have longer wait times to access health care (Burrows, Ryung, and Hamann 2012; Meit et al. 2014). Together, this constellation of factors may result in higher levels of unmet need for health care, lower quality health care, later detection and poorer management of chronic disease, and lack of access to care for acute conditions in nonmetro versus metro areas. Our cause of death analyses suggest that these factors are likely to play some
FIGURE 6A  Change in non-Hispanic white male life expectancy at birth between 1990–1992 and 2014–2016 and change in select area-level characteristics between 1990 and 2015, (% obeses 2004–2013)
FIGURE 6B  Change in non-Hispanic white female life expectancy at birth between 1990–1992 and 2014–2016 and change in select area-level characteristics between 1990 and 2015, (% obese 2004–2013)
role. In Figures 6A and 6B, we have graphed the change in life expectancy against the change in physician availability for the 40 areas. The increase in physician availability was greater in large central metros than in non-metro areas, although increases in life expectancy were only moderately positively correlated with changes in physician availability (0.28 for white men and 0.42 for white women). Nonmetro areas had the fewest physicians per 1,000 residents at the beginning and end of the period.

Poverty

It is also possible that differences in life expectancy trends across metro-nonmetro categories and regions are related to the changing characteristics of these areas between 1990 and 2016. For example, it is possible that life expectancy trends are related to variation in levels of or trends in poverty across the 40 geographic areas. The rural mortality disadvantage is sometimes attributed to higher levels of poverty in nonmetro areas (e.g., Stein et al. 2017). However, the data do not support the common narrative of rural economic disadvantage when measured by the level of poverty. According to a recent analysis by the US Census Bureau, poverty rates during 2011–2015 were consistently lower for those living in rural areas than for those living in urban areas in all Census regions, with the largest differences observed in the Midwest and Northeast. In 32 states, median household income was higher for rural households than for urban households (Bishaw and Posey 2016). The poverty advantage for rural areas is a product of adjustments for geographic differences in housing costs, the receipt of noncash benefits, and taxes paid; without these sensible adjustments, rural areas have slightly higher levels of poverty (United States Department of Agriculture Economic Research Service 2017).

Nolan, Waldfogel, and Wimer (2017) extend the analysis of rural/urban differences in poverty back to 1967 and adjust for real differences in cost of living and for taxes paid and transfers received. They find that in 1967, more than 30 percent of rural residents were living in poverty compared to 20 percent of urban residents. However, the rural poverty level fell much more quickly and by about 1992 was equal to that of urban residents. From 1992 onwards, rural poverty continued to fall more rapidly and was 3 percentage points below urban poverty levels by 2015. Both the cost of living adjustment and the introduction of taxes and transfers were instrumental in driving the relative improvements in rural poverty. A higher proportion of rural residents received assistance from social security, food stamps, and heating subsidies.4

The implications for interpreting the results of our analysis are clear: the deterioration of nonmetropolitan mortality relative to large central metros cannot be attributed to worsening absolute or relative poverty trends
in rural areas. On the contrary, trends in poverty since 1990 should have worked to reduce metro-nonmetro differences in life expectancy.

That rural areas have benefited from government transfers and receive a higher proportion of public assistance can also be an indicator of deteriorating labor market conditions and increased dependence on government subsidies. In Figures 6A and 6B, we have graphed the changes in life expectancy in the 40 areas against the change in the percentage of total personal income that is composed of government transfers (i.e., retirement and disability insurance benefits, medical benefits, income maintenance benefits, unemployment compensation, veterans’ benefits, and education and training assistance) and receipts of benefits from nonprofit institutions (Bureau of Economic Analysis 2018). The two variables are highly negatively correlated (–0.57 for men and –0.60 for women). Increases in life expectancy were smaller in areas where dependence on government transfers grew the most between 1990 and 2015.

Educational attainment

Another compositional change that is related to both mortality and changing characteristics of the population is educational attainment—one of the strongest predictors of mortality at the individual level (Elo 2009; Hendi 2015, 2017; Montez, Zajacova, and Hayward 2016b; Sheehan, Montez, and Sasson 2018). Both metro and nonmetro areas witnessed increases in the educational attainments of their residents between 1990 and 2015. However, these changes have been more favorable in metro than nonmetro areas. Given the steep educational gradient in mortality and its steepening, especially for white women, over the last decades (Hendi 2017), the increase in the proportion of college graduates in an area should translate into a decline in area-level mortality over time. The change in the proportion college educated was highly correlated with the change in life expectancy in our 40 areas (0.52 for men and 0.58 for women, Figures 6A and 6B).

Migration

Finally, we examined the relationship between life expectancy and migration of the working-age population. The migration rate of the working-age population is a useful proxy for the economic conditions and desirability of living in an area. If working-aged people are leaving an area, it may be in response to a lack of job opportunities. If working-aged people are moving to an area, it may indicate that that place provides greater opportunity (Castles, de Haas, and Miller 2014). We use variable-r methods to compute net in-migration rates by sex for people aged
22.5–62.5 years in each of our 40 areas in 1990–1992 and 2014–2016 (see Appendix for further detail). We find that in-migration of the working-age population is strongly and positively correlated with life expectancy gains (0.44 for women and 0.58 for men). Large central metros and suburbs have seen an increase in the rate of in-migration for working age people and have also seen the largest gains in life expectancy. Small and medium metros and nonmetros, on the other hand, have mostly experienced declines in net in-migration of the working-age population and have seen much smaller life expectancy gains.

Conclusions

Strong and steady improvements in life expectancy have been observed in industrialized countries for the better part of a century (Oeppen and Vaupel 2002). This salutary pattern has begun to fade in the United States in recent decades (Crimmins et al. 2011; Institute of Medicine and National Research Council 2013). In this article, we identify the geographic areas in the United States where the trends in mortality since 1990, and especially since 2010, are most problematic. We find that improvements in life expectancy have been slowest in nonmetropolitan areas and that actual declines have been observed there in recent years. People living in large central metros, on the other hand, have experienced rapid improvements in life expectancy, producing a striking metro-nonmetro divergence.

We have documented this divergence for white men and women by sex, age, cause of death, and geographic region. Our analysis provides some clues about the principal causal processes at work, but it is hardly definitive. Screenable cancers, HIV/AIDS, and influenza/pneumonia helped to widen the gap and suggest the possibility of a role for the quality of medical services. On the other hand, our study shows warning signs about rising mortality resulting from factors less clearly tied to the health care system. In particular, younger adults aged 25–44 have experienced rapid increases in mortality and are now contributing to declines in life expectancy across all metro-nonmetro categories. This rise in young adult mortality is largely attributable to drug overdose. We have presented suggestive evidence that changes in smoking and obesity are also implicated in the divergence. Metropolitan areas have benefited from a more rapid increase in the population with college degrees, a group with below-average mortality. Poverty trends are more advantageous in nonmetropolitan areas, but part of the reason is that these areas are receiving larger government benefits associated with labor force inactivity. There are many layers to the mosaic of metropolitan-nonmetropolitan mortality patterns. Continued efforts to identify the main factors at work are clearly justified by the massive divergence in the length of life that we have documented.
Notes

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1 Note that the alcohol-attributable and drug overdose mortality categories used in this article are the standard categories used by the NCHS and differ from the categories used in Case and Deaton (2015), which included all poisonings (including non-drug-related poisonings) and focused only on alcoholic liver diseases and fibrosis and cirrhosis of the liver (excluding other alcohol-attributable mortality).

2 Source: https://www.cdc.gov/nchs/data_access/urban_rural.htm.

3 Appendixes are available at the supporting information tab at wileyonlinelibrary.com/journal/pdr.

4 Somewhat ironically, rural residents feel neglected by political “elites” despite the disproportionate benefits that they derive from federal programs (Scala and Johnson 2017).

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