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Potentially Excess Deaths from the Five Leading Causes of Death in Metropolitan and Nonmetropolitan Counties — United States, 2010–2017

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CONTENTS

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Potentially Excess Deaths from the Five Leading Causes of Death in Metropolitan and Nonmetropolitan Counties — United States, 2010–2017

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Abstract

Problem/Condition: A 2017 report quantified the higher percentage of potentially excess (or preventable) deaths in nonmetropolitan areas (often referred to as rural areas) compared with metropolitan areas. In that report, CDC compared national, regional, and state estimates of potentially excess deaths among the five leading causes of death in nonmetropolitan and metropolitan counties for 2010 and 2014. This report enhances the geographic detail by using the six levels of the 2013 National Center for Health Statistics (NCHS) urban-rural classification scheme for counties and extending estimates of potentially excess deaths by annual percent change (APC) and for additional years (2010–2017). Trends were tested both with linear and quadratic terms.

Period Covered: 2010–2017.

Description of System: Mortality data for U.S. residents from the National Vital Statistics System were used to calculate potentially excess deaths from the five leading causes of death among persons aged <80 years. CDC's NCHS urban-rural classification scheme for counties was used to categorize the deaths according to the urban-rural county classification level of the decedent's county of residence (1: large central metropolitan [most urban], 2: large fringe metropolitan, 3: medium metropolitan, 4: small metropolitan, 5: micropolitan, and 6: noncore [most rural]). Potentially excess deaths were defined as deaths among persons aged <80 years that exceeded the number expected if the death rates for each cause in all states were equivalent to those in the benchmark states (i.e., the three states with the lowest rates). Potentially excess deaths were calculated separately for the six urban-rural county categories nationally, the 10 U.S. Department of Health and Human Services public health regions, and the 50 states and District of Columbia.

Results: The number of potentially excess deaths among persons aged <80 years in the United States increased during 2010–2017 for unintentional injuries (APC: 11.2%), decreased for cancer (APC: −9.1%), and remained stable for heart disease (APC: 1.1%), chronic lower respiratory disease (CLRD) (APC: 1.7%), and stroke (APC: 0.3). Across the United States, percentages of potentially excess deaths from the five leading causes were higher in nonmetropolitan counties in all years during 2010–2017. When assessed by the six urban-rural county classifications, percentages of potentially excess deaths in the most rural counties (noncore) were consistently higher than in the most urban counties (large central metropolitan) for the study period. Potentially excess deaths from heart disease increased most in micropolitan counties (APC: 2.5%) and decreased most in large fringe metropolitan counties (APC: −1.1%). Potentially excess deaths from cancer decreased in all county categories, with the largest decreases in large central metropolitan (APC: −16.1%) and large fringe metropolitan (APC: −15.1%) counties. In all county categories, potentially excess deaths from the five leading causes increased, with the largest increases occurring in large central metropolitan (APC: 18.3%), large fringe metropolitan (APC: 17.1%), and medium metropolitan (APC: 11.1%) counties. Potentially excess deaths from CLRD decreased most in large central metropolitan counties (APC: −5.6%) and increased most in micropolitan (APC: 3.7%) and noncore (APC: 3.6%) counties. In all county categories, potentially excess deaths from stroke exhibited a quadratic trend (i.e., decreased then increased), except in micropolitan counties, where no change occurred. Percentages of potentially excess deaths also differed among and within public health regions and across states by urban-rural county classification during 2010–2017.

Interpretation: Nonmetropolitan counties had higher percentages of potentially excess deaths from the five leading causes than metropolitan counties during 2010–2017 nationwide, across public health regions, and in the majority of states. The gap between the most rural and most urban counties for potentially excess deaths increased during 2010–2017 for three causes of death (cancer, heart disease, and CLRD), decreased for unintentional injury, and remained relatively stable for stroke. Urban and suburban counties (large central metropolitan and large fringe

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metropolitan, medium metropolitan, and small metropolitan) experienced increases in potentially excess deaths from unintentional injury during 2010–2017, leading to a narrower gap between the already high (approximately 55%) percentage of excess deaths in noncore and micropolitan counties.

Public Health Action: Routine tracking of potentially excess deaths by urban-rural county classification might help public health departments and decision-makers identify and monitor public health problems and focus interventions to reduce potentially excess deaths in these areas.

Introduction

Approximately one fifth of the U.S. population (60 million persons) lives in nonmetropolitan (rural) areas, which comprise 97% of the U.S. land area (*1*). The demographic, environmental, economic, and social characteristics of nonmetropolitan and metropolitan counties differ, which influences the prevalence of adverse health outcomes and associated risk factors. Nonmetropolitan areas have a higher prevalence of cigarette smoking, hypertension, obesity, and physical inactivity during leisure time (*2*). Approximately 17% of the U.S. population who lives at or below the poverty threshold, which was $24,600 for a family with two adults and two children in 2017 (*3*), lives in nonmetropolitan areas; however, 31% of nonmetropolitan counties have concentrated poverty, where at least one fifth of the population is poor, compared with 15%–19% of metropolitan counties (*4*). Availability of resources for preventive services and access to health care also is more limited in nonmetropolitan areas. Residents of nonmetropolitan counties are more likely to report less access to health care and lower quality of health care (*2*). Metropolitan areas generally have a greater density and diversity of health care providers than nonmetropolitan areas (*5*,*6*).

In 2017, the five leading causes of death in the United States were heart disease, cancer, unintentional injury, chronic lower respiratory disease (CLRD), and stroke, which together accounted for 1,723,085 deaths (approximately 61% of all deaths) (*7*). Four of the five leading causes of death were chronic diseases, two of which (heart disease and cancer) accounted for approximately 44% of all deaths in 2017 (*7*). Potentially excess deaths (also described as potentially preventable deaths) are defined as deaths among persons aged <80 years in excess of the number that would be expected if the death rates for each cause in all states were equivalent to those in the benchmark states (i.e., the three states with the lowest rates) (*8*,*9*). To provide a health equity perspective, every state is compared with the same benchmark rates regardless of demographic differences.

Many factors contribute to mortality, and not all potentially excess deaths can be prevented by public health interventions alone. For example, some areas might have characteristics that predispose persons to higher rates of death, such as long travel distances to specialty or emergency care or exposures to specific environmental hazards, as well as possible geographic genetic clustering. Many potentially excess deaths might be prevented through multisector programs that address broader social determinants of health (e.g., education, employment, and housing), improved public health programs that support healthier behaviors and neighborhoods, or improved access to quality health care services (*10*).

CDC previously analyzed and compared 2010 and 2014 mortality data from the National Vital Statistics System (NVSS) to examine differences in the five leading causes of death in U.S. nonmetropolitan and metropolitan areas (*11*). Assessing potentially excess deaths using the binary nonmetropolitan and metropolitan classifications for counties might mask important differences within urban and rural areas. For example, considerable variation occurs in settlement patterns and density among nonmetropolitan counties; some include small towns, and other areas are classified as frontier counties with no urban areas. Considerable variation in measures of health also might occur within metropolitan counties; suburban metropolitan counties tend to have substantially better health outcomes than inner-city metropolitan counties (*5*). To account for these variations, deaths were categorized by the six levels of the 2013 National Center for Health Statistics (NCHS) urban-rural classification scheme for counties (*8*).

This report presents estimates, percentages, and annual percent changes (APCs) for potentially excess deaths by urban-rural county classification from the five leading causes of death during 2010–2017. Linear and quadratic trends from 2010 to 2017 also were calculated. Routine tracking of potentially excess deaths in nonmetropolitan areas might help public health departments identify emerging health problems, monitor known problems, and focus interventions to reduce potentially excess deaths in these areas.

Methods

Mortality data for U.S. residents from NVSS (https://www.cdc.gov/nchs/nvss/index.htm) were used to calculate potentially excess deaths by urban-rural county classification from the five leading causes of death during 2010–2017 (heart disease,

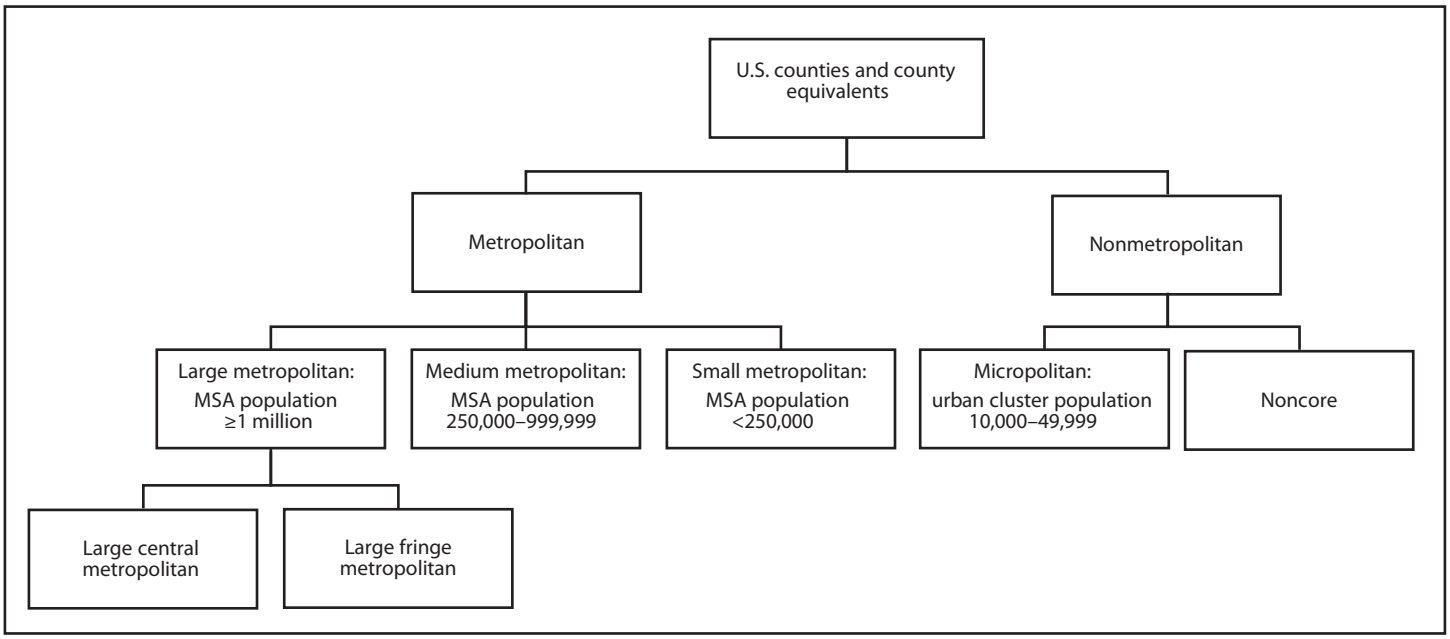
cancer, unintentional injury, CLRD, and stroke). Urban-rural categories were identified using the NCHS 2013 urban-rural classification scheme for counties (*12*) (Figure 1). County of residence of the decedent was used to determine urban-rural county classification; the categories, from the most urban to the most rural, are 1) large central metropolitan (most urban), 2) large fringe metropolitan, 3) medium metropolitan, 4) small metropolitan, 5) micropolitan, and 6) noncore (most rural). The terms nonmetropolitan and metropolitan are used in this report, although in other settings and publications the terms rural and nonmetropolitan often are used interchangeably, as are the terms urban and metropolitan (*13*). Potentially excess deaths were calculated for the two nonmetropolitan categories (noncore and micropolitan) and the four metropolitan categories individually, as well as for the broader categories of metropolitan and nonmetropolitan.

Analyses were restricted to deaths with an underlying cause of death among the five leading causes based on the *International Classification of Diseases, 10th Revision* (ICD-10): heart disease (I00–I09, I11, I13, and I20–I51), cancer (C00–C97), unintentional injury (V01–X59 and Y85–Y86), CLRD (J40–J47), and stroke (I60–I69). The analysis of potentially excess deaths during 2010–2017 was restricted to persons aged <80 years at the time of death; the age restriction is consistent with the average life expectancy for the total U.S. population, which was approximately 79 years in 2010 (*8*).

Numbers of potentially excess deaths for each of the five leading causes of death were calculated using methods described previously (*8*). For each age group and cause, the death rates of the three states previously published with the lowest rates during 2008–2010 (benchmark states) (*8*) were averaged to produce benchmark rates (https://stacks.cdc.gov/view/cdc/42342). The same benchmarks were applied both to nonmetropolitan (i.e., micropolitan and noncore) and metropolitan (i.e., large central metropolitan, large fringe metropolitan, medium metropolitan, and small metropolitan) counties, and benchmarks were not adjusted for other characteristics that might affect death rates (e.g., race, ethnicity, and socioeconomic status).

Estimates of the expected number of deaths for each specific age group, cause of death, and urban-rural county classification were calculated by multiplying population estimates for age, cause, state, and urban-rural county classification by the benchmark death rates, and the expected deaths were subtracted from observed deaths to yield potentially excess deaths. Potentially excess deaths for age, cause, state, and

FIGURE 1. National Center for Health Statistics (2013) urban-rural county classification scheme* for counties



Source: Ingram DD, Franco SJ. 2013 NCHS urban–rural classification scheme for counties. Vital Health Stat 2014;2(166). https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

Abbreviation: MSA = metropolitan statistical area.

* Large central metropolitan: counties in MSAs of ≥1 million population that 1) contain the entire population of the largest principal city of the MSA, 2) are completely contained within the largest principal city of the MSA, or 3) contain at least 250,000 residents of any principal city in the MSA. Large fringe metropolitan: counties in MSAs of ≥1 million population that do not qualify as large central metropolitan counties (**Source:** CDC, National Center for Health Statistics. NCHS urban-rural classification scheme for counties. Rockville, MD: National Center for Health Statistics, CDC, US Department of Health and Human Services. https://www.cdc.gov/nchs/data_access/urban_rural.htm).

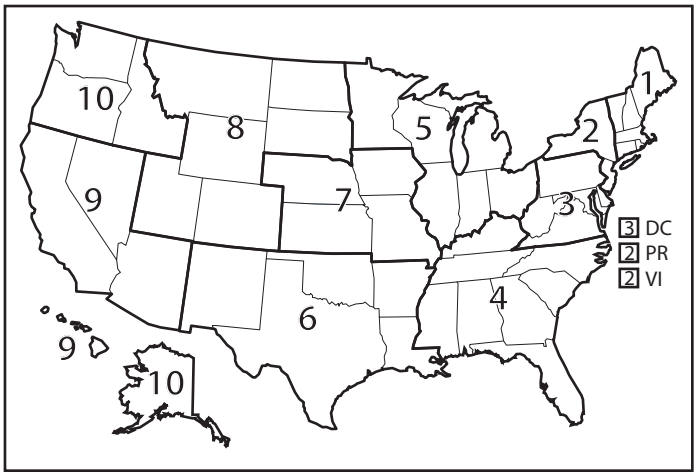
urban-rural county classification were summed across age groups to produce estimates for cause of death, state, and urban-rural county classification and across states to produce estimates for cause and urban-rural county classification for the 10 U.S. Department of Health and Human Services (HHS) public health regions (Figure 2) and the United States. Certain estimates of potentially excess deaths were negative (i.e., lower than benchmark rates) because of strata with fewer deaths than expected (typically from one or two of the benchmark states or a state close to the average of the three benchmark states or when metropolitan areas of a state fell below the benchmark because the proportion of observed deaths is higher for nonmetropolitan counties combined); these negative estimates were set to zero. For each cause of death, the percentage of deaths that were potentially excess was calculated by dividing the potentially excess death estimates for cause of death, state, HHS region, and urban-rural county classification by the observed number of deaths for that same stratum.

The number of potentially excess deaths for each cause were assumed to follow a Poisson distribution, and standard errors for both the number and percentage of excess deaths were calculated using standard formulas that incorporated the variance around both the observed and the expected counts. Trends in the numbers of potentially excess deaths during 2010–2017 by cause, state, HHS region, and urban-rural county classification were assessed using Poisson regression models. The coefficients for year were used to calculate APC estimates (APC = 100*(exp[coefficient]–1), and the statistical significance of linear trends was assessed using a Bonferroni adjustment to account for the multiple comparisons of the different cause, state, HHS region, and urban-rural county classification strata (α = 0.05 / 1,420, p<0.001). To assess whether certain trends were quadratic (e.g., U- or J-shaped instead of a straight line), quadratic terms were added to the models, with statistically significant quadratic trends identified using the same Bonferroni adjustment described.

Results

Both in nonmetropolitan and metropolitan counties, the five leading causes of death in the United States during 2010–2017 were heart disease, cancer, unintentional injury, CLRD, and stroke, which accounted for 1.72 million deaths (approximately 61% of all deaths) in 2017 (*7*). Four of the five leading causes of death were chronic diseases, two of which (heart disease and cancer) accounted for the majority of deaths among persons aged <80 years in 2017 (Figure 3).

FIGURE 2. U.S. Department of Health and Human Services public health regions*



Source: Moy E, García MG, Bastian B, et al. Leading causes of death in nonmetropolitan and metropolitan areas—United States, 1999–2014. MMWR Surveill Summ 2017;66(No. SS-1).

* 1 = Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; 2 = New Jersey, New York, Puerto Rico, and the U.S. Virgin Islands (Mortality data for residents of U.S. territories were excluded.); 3 = Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia; 4 = Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee; 5 = Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin; 6 = Arkansas, Louisiana, New Mexico, Oklahoma, and Texas; 7 = Iowa, Kansas, Missouri, and Nebraska; 8 = Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming; 9 = Arizona, California, Hawaii, and Nevada; 10 = Alaska, Idaho, Oregon, and Washington.

National Aggregation

The number of potentially excess deaths in the United States increased during 2010–2017 for unintentional injury (APC: 11.2%), with the quadratic trend suggesting that the increase accelerated in more recent years, primarily as a result of increases in deaths related to drug poisoning, including opioid overdose (Supplementary Figure, https://stacks.cdc.gov/view/cdc/81888). The number of potentially excess deaths attributed to CLRD also increased (APC: 1.7%). Potentially excess deaths decreased for cancer (APC: –9.1%) (Table), with the quadratic trend suggesting that the decrease was more rapid in recent years. Trends for both heart disease and stroke initially decreased and then stabilized (Figure 4).

When death rates were assessed in the six urban-rural county categories, a persistent disparity was identified between the most rural counties (noncore) and the most urban counties (large central metropolitan and large fringe metropolitan) for the study period. Although the number of persons aged <80 years living in nonmetropolitan counties of the United States decreased from 44.3 million in 2010 to 43.9 million in 2017 (an average of 0.1% per year), potentially excess deaths in nonmetropolitan counties (both micropolitan and noncore)

FIGURE 3. Number of deaths among persons aged <80 years from the five leading causes of death, by urban-rural county classification — National Vital Statistics System, United States, 2017

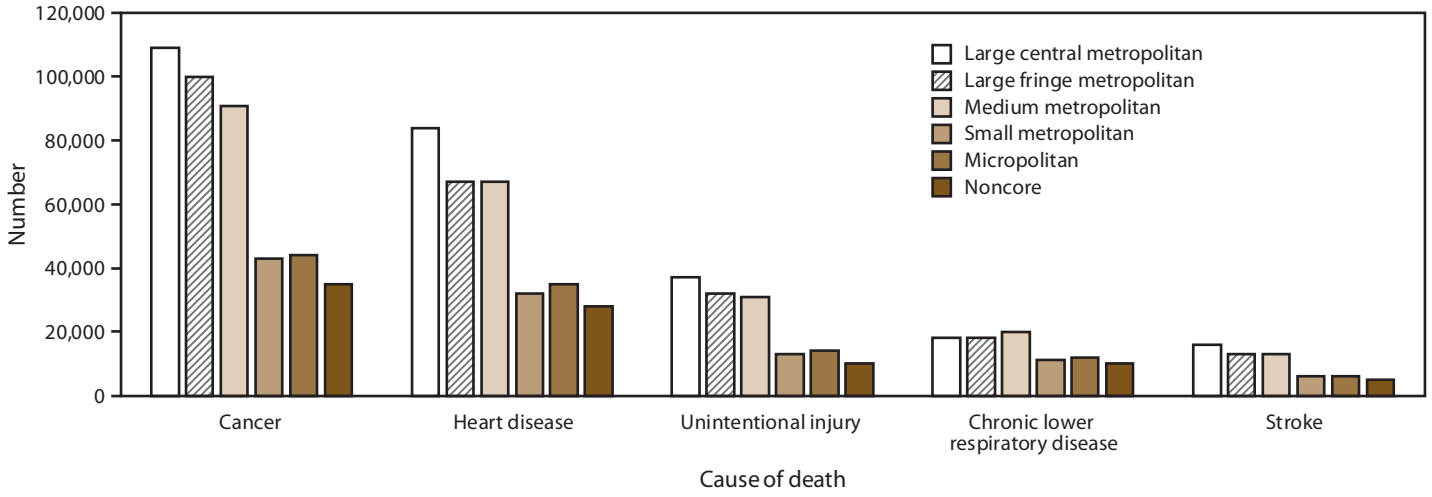
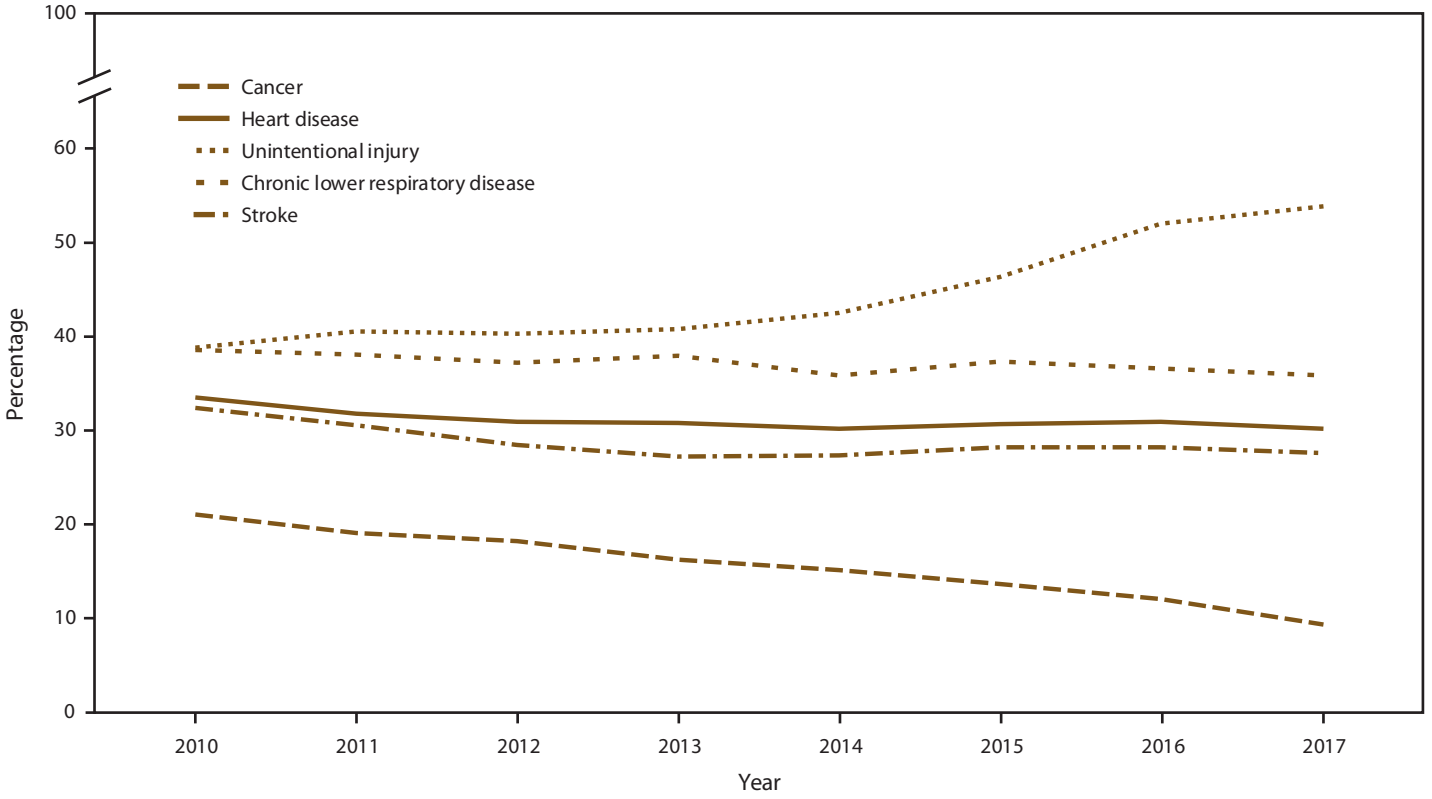


FIGURE 4. Percentage of deaths that were potentially excess* among persons aged <80 years from the five leading causes of death — National Vital Statistics System, United States, 2010–2017



* Potentially excess deaths are defined as deaths among persons aged <80 years in excess of the number that would be expected if the death rates for each cause in all states were equivalent to those in the benchmark states (i.e., the three states with the lowest rates).

increased for heart disease, unintentional injury, and CLRD; decreased for cancer; and exhibited a quadratic trend for stroke in noncore counties (i.e., decreased then increased) (Table) (Figure 5). Similar trends were observed for medium and small metropolitan counties. Large central and large fringe metropolitan counties experienced decreases in the numbers

TABLE. Number* and percentage of potentially excess deaths among persons aged <80 years from the five leading causes of death, by urban–rural county classification — National Vital Statistics System, United States, 2010–2017

Cause of death and county classification	2010	2011	2012	2013	2014	2015	2016	2017	APC	SE	95% CI
Heart disease											
Large central metropolitan†	24,859 (33.5)	23,836 (31.9)	23,173 (30.8)	23,344 (30.3)	22,655 (29.0)	23,660 (29.4)	24,515 (29.7)	23,496 (28.0)	−0.3	0.1	−0.5 to 0.0
Large fringe metropolitan†,§	13,945 (24.1)	12,360 (21.4)	11,574 (19.9)	11,358 (19.0)	11,261 (18.4)	11,762 (18.6)	12,159 (18.7)	12,399 (18.5)	−1.1	0.1	−1.5 to −0.8
Medium metropolitan†,§	17,781 (31.7)	17,089 (30.3)	17,130 (29.8)	17,992 (30.2)	17,999 (29.6)	18,951 (30.1)	19,583 (30.3)	20,029 (30.1)	2.2	0.1	1.9 to 2.5
Small metropolitan†,§	10,420 (36.9)	10,021 (35.5)	9,924 (34.7)	10,147 (34.7)	10,295 (34.4)	10,686 (34.7)	11,089 (35.1)	11,282 (34.8)	1.6	0.2	1.2 to 2.0
Micropolitan†,§	12,913 (42.0)	12,320 (40.4)	12,585 (40.5)	12,861 (40.5)	13,139 (40.5)	14,326 (42.2)	14,445 (42.1)	14,611 (41.8)	2.5	0.1	2.2 to 2.9
Noncore§	11,509 (45.1)	11,111 (43.9)	11,132 (43.5)	11,556 (44.0)	12,015 (44.6)	12,384 (45.1)	12,892 (45.8)	12,644 (44.9)	2.1	0.1	1.8 to 2.5
Total†,§	**91,427 (33.5)**	**86,738 (31.8)**	**85,519 (31.0)**	**87,258 (30.8)**	**87,364 (30.2)**	**91,760 (30.7)**	**94,676 (30.9)**	**94,452 (30.1)**	**1.1**	**0.1**	**0.9 to 1.2**
Cancer											
Large central metropolitan†,§	18,754 (17.9)	16,709 (15.8)	15,945 (14.9)	12,844 (12.0)	11,830 (10.9)	9,546 (8.7)	7,693 (7.0)	3,443 (3.2)	−16.1	0.2	−16.5 to −15.7
Large fringe metropolitan†,§	16,566 (17.7)	14,208 (15.2)	12,930 (13.6)	11,229 (11.7)	9,870 (10.1)	8,102 (8.3)	6,948 (7.0)	4,000 (4.0)	−15.1	0.2	−15.5 to −14.7
Medium metropolitan†,§	18,252 (21.4)	16,330 (19.2)	16,337 (18.8)	14,635 (16.7)	14,282 (16.0)	13,232 (14.7)	11,366 (12.6)	9,328 (10.3)	−7.9	0.1	−8.2 to −7.5
Small metropolitan†,§	9,606 (23.6)	8,883 (21.8)	8,836 (21.3)	8,265 (19.8)	7,773 (18.4)	7,500 (17.6)	6,798 (15.9)	5,766 (13.5)	−6.1	0.2	−6.6 to −5.7
Micropolitan†,§	11,313 (26.7)	11,254 (26.1)	10,912 (25.2)	10,837 (24.7)	10,060 (23.0)	10,050 (22.6)	9,416 (21.3)	8,819 (19.9)	−3.4	0.2	−3.8 to −3.0
Noncore§	9,806 (28.7)	9,503 (27.7)	9,192 (26.7)	8,831 (25.6)	8,723 (25.1)	8,564 (24.5)	8,321 (23.8)	7,538 (21.7)	−3.2	0.2	−3.6 to −2.7
Total†,§	**84,297 (21.0)**	**76,887 (19.1)**	**74,152 (18.2)**	**66,440 (16.2)**	**62,538 (15.0)**	**56,979 (13.6)**	**50,527 (12.0)**	**38,879 (9.2)**	**−9.1**	**0.1**	**−9.2 to −8.9**
Unintentional injury											
Large central metropolitan†,§	5,924 (25.4)	6,941 (28.2)	7,072 (28.2)	8,024 (30.6)	9,021 (32.8)	11,168 (37.3)	15,900 (45.7)	17,580 (47.8)	18.3	0.2	17.9 to 18.7
Large fringe metropolitan†,§	5,765 (28.8)	6,645 (31.5)	7,059 (32.5)	7,229 (32.7)	8,049 (34.8)	10,236 (40.1)	14,422 (48.2)	16,118 (50.6)	17.1	0.2	16.6 to 17.5
Medium metropolitan†,§	9,129 (43.1)	9,589 (43.9)	9,242 (42.8)	9,804 (43.9)	10,808 (46.0)	12,849 (50.1)	15,930 (55.2)	17,774 (57.6)	11.1	0.1	10.8 to 11.5
Small metropolitan†,§	4,342 (44.5)	4,775 (46.6)	4,546 (45.1)	4,715 (45.9)	5,197 (48.0)	5,892 (51.0)	6,587 (53.6)	7,171 (55.5)	7.7	0.2	7.1 to 8.2
Micropolitan†,§	5,865 (53.1)	6,293 (54.7)	6,263 (54.5)	6,107 (53.7)	6,375 (54.7)	6,973 (56.8)	7,786 (59.5)	8,376 (61.1)	5.0	0.2	4.5 to 5.5
Noncore†,§	5,781 (60.9)	5,972 (61.6)	5,924 (61.4)	5,656 (60.2)	5,758 (60.6)	6,304 (62.8)	6,683 (64.2)	6,673 (64.1)	2.2	0.2	1.7 to 2.7
Total†,§	**36,807 (38.8)**	**40,216 (40.6)**	**40,105 (40.3)**	**41,536 (40.8)**	**45,208 (42.6)**	**53,419 (46.4)**	**67,304 (52.0)**	**73,687 (54.0)**	**11.2**	**0.1**	**11.0 to 11.3**
Chronic lower respiratory disease											
Large central metropolitan§	3,756 (23.4)	3,587 (22.1)	3,250 (20.0)	3,581 (21.0)	2,627 (15.9)	2,986 (17.2)	2,906 (16.5)	2,322 (13.0)	−5.6	0.3	−6.4 to −4.9
Large fringe metropolitan§	4,546 (29.4)	4,717 (29.5)	4,244 (26.6)	4,357 (26.4)	4,136 (24.6)	4,472 (25.5)	4,237 (23.9)	4,314 (23.4)	−1.0	0.2	−1.6 to −0.4
Medium metropolitan§	6,794 (41.1)	6,815 (40.4)	6,928 (40.1)	7,426 (41.0)	7,275 (39.6)	7,714 (40.3)	7,970 (40.4)	8,104 (39.8)	2.8	0.2	2.3 to 3.3
Small metropolitan§	4,079 (47.1)	4,225 (47.3)	4,243 (46.8)	4,613 (48.1)	4,377 (46.0)	4,928 (48.3)	4,916 (47.6)	5,024 (47.2)	3.2	0.2	2.6 to 3.8
Micropolitan§	5,203 (53.1)	5,284 (52.9)	5,413 (53.0)	5,906 (54.5)	5,843 (53.6)	6,355 (55.2)	6,441 (55.0)	6,538 (54.6)	3.7	0.2	3.2 to 4.2
Noncore§	4,342 (54.3)	4,434 (54.3)	4,621 (54.9)	4,807 (55.3)	4,801 (54.7)	5,307 (56.8)	5,153 (55.8)	5,586 (57.1)	3.6	0.2	3.0 to 4.1
Total§	**28,720 (38.6)**	**29,062 (38.2)**	**28,699 (37.2)**	**30,690 (38.0)**	**29,059 (35.9)**	**31,760 (37.3)**	**31,621 (36.6)**	**31,886 (35.8)**	**1.7**	**0.1**	**1.5 to 1.9**
Stroke											
Large central metropolitan†	4,465 (31.7)	4,263 (30.1)	3,838 (27.5)	3,806 (26.7)	3,779 (25.9)	4,132 (27.1)	4,391 (27.9)	4,506 (27.4)	0.5	0.2	−0.1 to 1.1
Large fringe metropolitan†	2,494 (22.7)	2,227 (20.3)	2,209 (19.7)	1,732 (15.6)	2,009 (17.1)	2,333 (18.9)	2,345 (18.5)	2,209 (17.0)	−0.4	0.3	−1.3 to 0.4
Medium metropolitan†	3,762 (33.3)	3,527 (31.3)	3,220 (28.9)	3,258 (28.4)	3,492 (29.2)	3,665 (29.6)	3,667 (29.1)	3,784 (28.9)	0.8	0.3	0.2 to 1.5
Small metropolitan†	1,886 (34.9)	1,795 (33.3)	1,623 (30.5)	1,625 (29.9)	1,651 (29.7)	1,817 (31.2)	1,882 (31.4)	1,941 (31.4)	1.0	0.4	0.0 to 1.9
Micropolitan	2,393 (40.5)	2,255 (38.6)	2,229 (37.9)	2,211 (37.1)	2,183 (36.3)	2,251 (36.5)	2,212 (35.8)	2,201 (35.0)	−0.8	0.3	−1.7 to 0.0
Noncore†	1,970 (41.6)	1,939 (40.8)	1,723 (37.5)	1,745 (37.3)	1,854 (38.3)	1,808 (37.4)	1,956 (39.0)	1,906 (37.8)	0.0	0.4	−0.9 to 0.9
Total†	**16,970 (32.4)**	**16,007 (30.6)**	**14,841 (28.4)**	**14,379 (27.2)**	**14,970 (27.4)**	**16,004 (28.2)**	**16,453 (28.3)**	**16,544 (27.6)**	**0.3**	**0.1**	**−0.1 to 0.6**

Abbreviations: APC = annual percent change; CI = confidence interval; SE = standard error.

* The number of potentially excess deaths from all causes should not be combined to generate a total because the underlying causes might be related. In addition, numbers of excess deaths by urban-rural county category might not sum to the total within each cause because excess deaths were calculated separately by county category and for the United States. The statistical significance of linear trends was assessed using a Bonferroni adjustment to account for the multiple comparisons of the different classification strata ($\alpha = 0.05 / 1{,}420$, $p<0.001$). To assess whether certain trends were quadratic, quadratic terms were added to the models, with statistically significant quadratic trends identified using the same Bonferroni adjustment described.

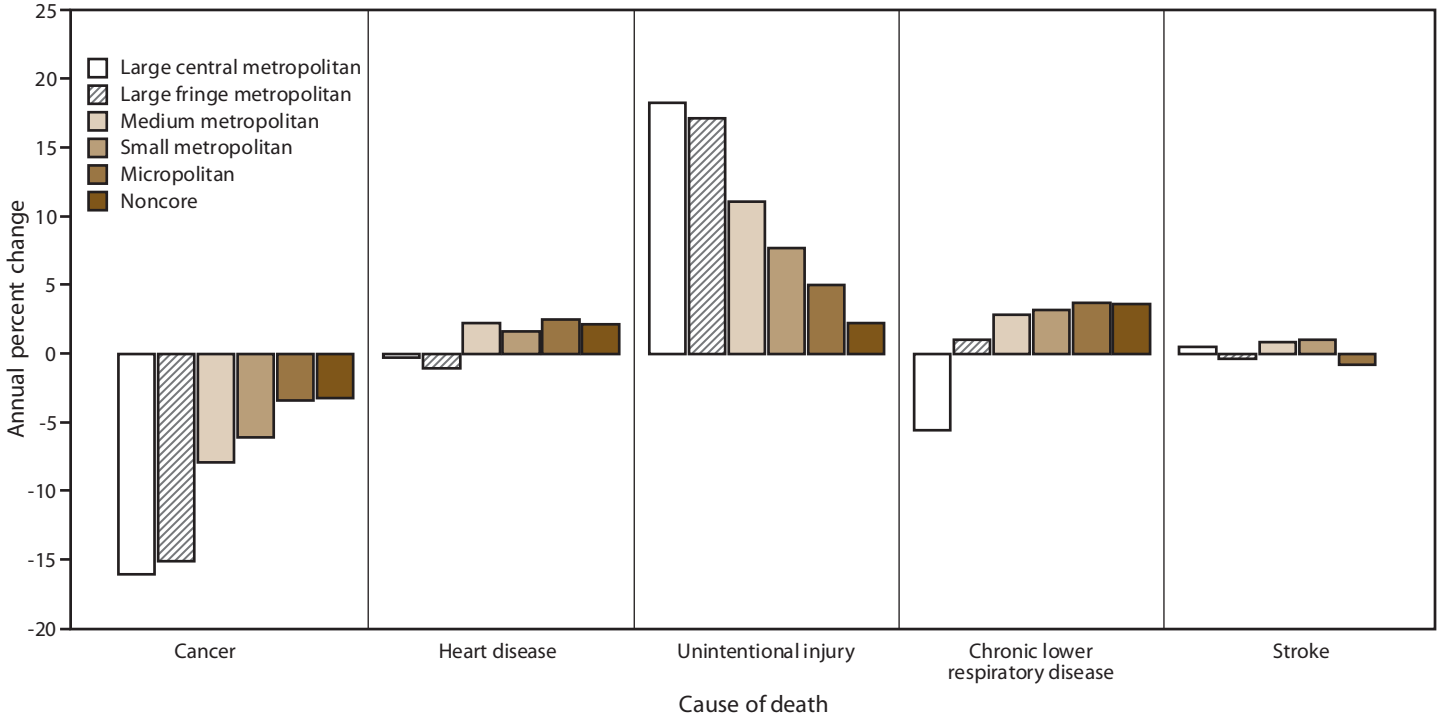
† Statistically significant quadratic trend.

§ Statistically significant linear trend.

of potentially excess deaths from cancer and CLRD, with quadratic trends for heart disease and stroke (Table).

Potentially excess deaths from unintentional injury increased across most urban-rural county categories, with the highest increases in large central and large fringe metropolitan counties (18% and 17%, respectively) (Figure 5). Among subcategories of unintentional injury deaths for all ages, age-adjusted death rates for poisonings increased 89%, followed

FIGURE 5. Annual percent change in potentially excess deaths* among persons aged <80 years from the five leading causes of death, by urban-rural county classification — National Vital Statistics System, United States, 2010–2017



* Potentially excess deaths are defined as deaths among persons aged <80 years in excess of the number that would be expected if the death rates for each cause in all states were equivalent to those in the benchmark states (i.e., the three states with the lowest rates).

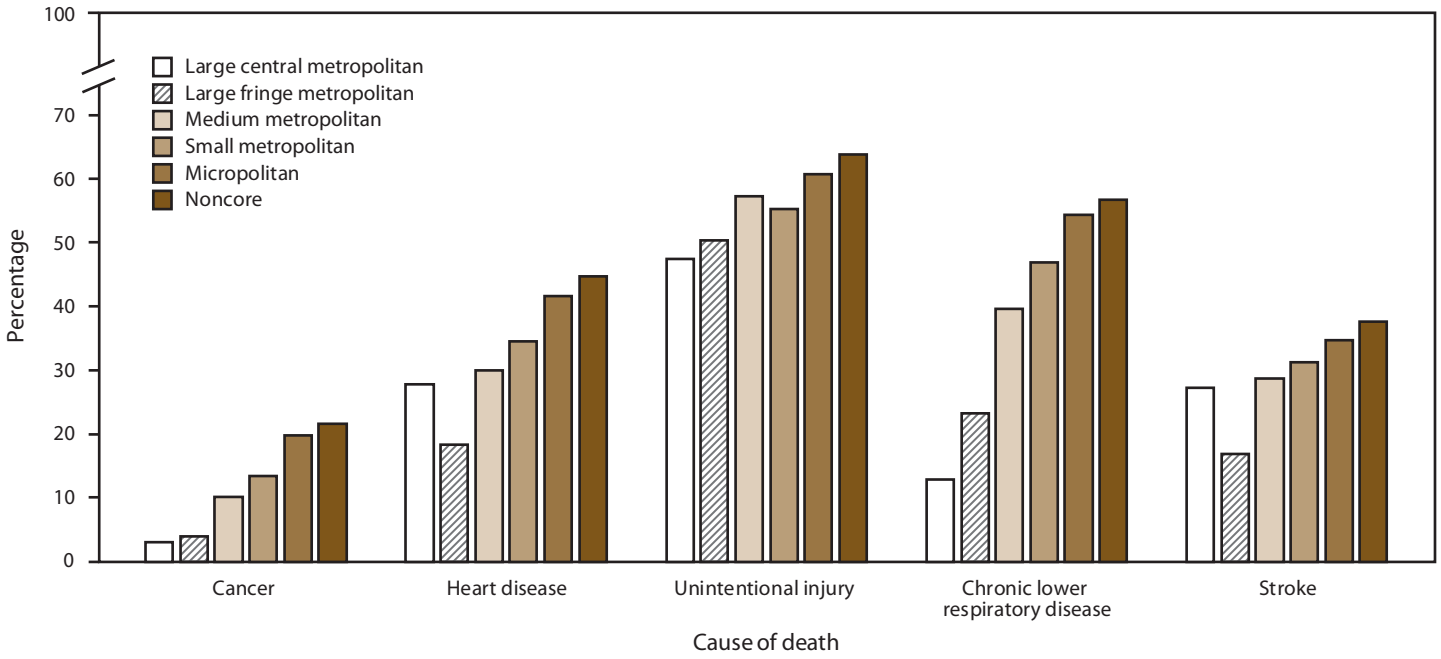
by an increase in falls (19%) and an increase in motor vehicle traffic (7%) from 2010–2017 in all urban-rural county classifications (*14*) (Supplementary Figure, https://stacks.cdc.gov/view/cdc/81888). From 2010 to 2017, age-adjusted death rates from drug poisoning increased by 119.3% in large fringe metropolitan counties but by 30.8% in the most rural (noncore) counties (*14*). In medium metropolitan counties, age-adjusted death rates from drug poisoning increased by 86.3% and in large central metropolitan counties by 91.0%, approximately 25–30 percentage points lower than in large fringe metropolitan counties.

Noncore counties, which are the most rural counties, had a higher percentage of deaths that were potentially excess from the five the leading causes than the other five urban-rural county categories every year of the study period (Table). In 2017, the percentages of deaths that were potentially excess from the five leading causes of death in noncore counties were 64.1% for unintentional injury, 57.1% for CLRD, 44.9% for heart disease, 21.7% for cancer, and 37.8% for stroke (Figure 6). The lowest percentage of potentially excess deaths from the five leading causes occurred in the most urban counties (large central metropolitan and large fringe metropolitan counties). For example, in 2017, 44.9% of heart disease deaths among persons aged <80 years in noncore counties were potentially excess deaths, compared with 18.5% in large fringe metropolitan counties, which had the lowest percentage of deaths that were potentially excess. A total of 64.1% of deaths among persons aged <80 years from unintentional injury in noncore counties were potentially excess deaths, compared with 47.8% in large central metropolitan counties. The largest disparity in potentially excess deaths between the most rural and most urban counties was from CLRD, for which 57.1% of deaths were potentially excess in noncore counties and 13.0% in large central metropolitan counties.

Regional Differences

The percentages of deaths that were potentially excess from the five leading causes varied widely across HHS public health regions and by cause of death (Supplementary Table 1, https://stacks.cdc.gov/view/cdc/81884; Supplementary Table 2, https://stacks.cdc.gov/view/cdc/81885). For cancer, the percentage of excess deaths in noncore counties in 2017 ranged from 31.2% in region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee) to 0% in region 9 (Arizona, California, Hawaii, and Nevada). In large central metropolitan counties, the percentage of excess deaths

FIGURE 6. Percentage of deaths that were potentially excess* among persons aged <80 years from the five leading causes of death, by urban-rural county classification — National Vital Statistics System, United States, 2017



* Potentially excess deaths are defined as deaths among persons aged <80 years in excess of the number that would be expected if the death rates for each cause in all states were equivalent to those in the benchmark states (i.e., the three states with the lowest rates).

from cancer ranged from 21.8% in region 7 (Iowa, Kansas, Missouri, and Nebraska) to 0% in regions 8 (Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming), 9, and 10 (Alaska, Idaho, Oregon, and Washington). For heart disease, the percentage of excess deaths in noncore counties in 2017 ranged from 55.8% in region 4 to 13% in region 1 (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont). In large central metropolitan counties, the percentage of excess deaths from heart disease ranged from 47.2% in region 7 to 0% in region 10. For unintentional injury, the percentage of excess deaths in noncore counties in 2017 ranged from 71.6% in region 9 to 45.6% in region 2 (New Jersey and New York). In large central metropolitan counties, the percentage of excess deaths from unintentional injury ranged from 69.4% in region 7 to 33.3% in region 9.

State Highlights

Heart Disease

The percentage of potentially excess deaths from heart disease in the United States was 30.1% in 2017 (Table) (Supplementary Table 3, https://stacks.cdc.gov/view/cdc/81886; Supplementary Table 4, https://stacks.cdc.gov/view/cdc/81887). Among the states with reliable trend data, the number of potentially excess deaths in nonmetropolitan counties increased for heart disease in 18 states, whereas in metropolitan counties, 12 states experienced decreases in the number of potentially excess deaths. Decreases in potentially excess deaths from heart disease in metropolitan counties ranged from −33.8% to −0.8%, with two states experiencing APCs of −34% (Massachusetts) and −31% (North Dakota). Increases in potentially excess deaths from heart disease in metropolitan counties ranged from <0.5% (South Carolina) to 48.4% (Vermont). In nonmetropolitan counties, decreases in potentially excess deaths from heart disease ranged from −0.2% (Montana) to −10.8% (Utah). Increases in potentially excess deaths in nonmetropolitan counties ranged from 0.6% (South Carolina) to 8.2% (Oregon and Arizona).

Cancer

The percentage of potentially excess deaths from cancer in the United States was 9.2% in 2017 (Table) (Supplementary Table 3, https://stacks.cdc.gov/view/cdc/81886; Supplementary Table 4, https://stacks.cdc.gov/view/cdc/81887). In metropolitan counties, potentially excess deaths from cancer decreased in all states. Decreases in potentially excess deaths from cancer in metropolitan counties ranged from −76.5% (Colorado) to −2.9% (Oklahoma), with two states (California and New Mexico) experiencing APCs of −42% and −54%, respectively. In nonmetropolitan counties, decreases in potentially excess

deaths from cancer ranged from −48.8% (Connecticut) to −0.3% (Georgia), with two states experiencing APCs of −45% and −30%, respectively (Wyoming and Arizona). Massachusetts was the only state to experience an increase in potentially excess deaths from cancer in nonmetropolitan counties (APC: 17.7%).

Unintentional Injury

The percentage of potentially excess deaths from unintentional injury in the United States was 54% in 2017 (Table) (Supplementary Table 3, https://stacks.cdc.gov/view/cdc/81886; Supplementary Table 4, https://stacks.cdc.gov/view/cdc/81887). In metropolitan counties, potentially excess deaths from unintentional injury increased in most states. Increases in potentially excess deaths from unintentional injury in metropolitan counties ranged from 70.8% (Maryland) to 1.3% (Mississippi), with states in the northeast experiencing APCs between 13% (Rhode Island) and 43% (New York). Wyoming was the only state that experienced a decrease in the number of potentially excess deaths from unintentional injury in metropolitan counties. In nonmetropolitan counties, the number of potentially excess deaths from unintentional injury increased in most states, but more slowly than in metropolitan counties. Increases in potentially excess deaths from unintentional injury in nonmetropolitan counties ranged from 27.2% (Massachusetts) to 0.6% (Oklahoma). Several states (i.e., Arkansas, Kentucky, Montana, and Nevada) experienced a decrease in the number of potentially excess deaths from unintentional injury in nonmetropolitan counties. State-level results for potentially excess deaths from CLRD and stroke by metropolitan and nonmetropolitan county categories are available (Supplementary Table 3, https://stacks.cdc.gov/view/cdc/81886; Supplementary Table 4, https://stacks.cdc.gov/view/cdc/81887); (https://tabsoft.co/2BxWUg0).

Discussion

Assessing trends for potentially excess deaths from the five leading causes in the United States according to the six NCHS urban-rural county classifications revealed differences within the previously reported larger binary urban-rural categories (*9*). For example, during 2010–2017, potentially excess deaths from heart disease decreased in large fringe metropolitan counties but increased in medium metropolitan, small metropolitan, micropolitan, and noncore (nonmetropolitan) counties. Combining medium metropolitan and small metropolitan counties with more urban counties masks disparities within the broader metropolitan-nonmetropolitan classification.

Large central metropolitan and large fringe metropolitan counties had lower percentages of potentially excess deaths than medium metropolitan, small metropolitan, micropolitan, and noncore counties for heart disease, cancer, and CLRD. The opposite is true for potentially excess deaths from unintentional injury, for which large central metropolitan, large fringe metropolitan, and medium metropolitan counties experienced the largest increases per year (ranging from 18.3% to 11.1%), and the most rural counties (noncore) experienced the smallest increases (2.2%). Although disparities in potentially excess deaths have increased between the most urban and the most rural counties over time for four of the five leading causes of death, the disparity has increased the most for excess deaths from CLRD.

Rural populations experience substantial health disparities when compared with more urban populations, including a higher prevalence of diseases such as obesity, increased mortality rates, and lower life expectancies. Risk factors contributing to these rural health disparities vary and have been well documented (*15*). Potential strategies for addressing unique factors that increase the risk for death among rural residents have been reported previously (*16*).

Limitations

The findings in this report are subject to at least six limitations. First, for each leading cause of death, the same benchmarks based on the three states with the lowest death rates were applied to all urban-rural county categories. Using the lowest rates to estimate expected deaths could skew the results toward a higher number of potentially excess deaths; however, by applying this standard to all categories and using an average of the lowest states over 3 years, these benchmark rates are fair and facilitate comparisons among categories. Overall, using urban-rural–specific benchmarks likely resulted in larger numbers of potentially excess deaths in certain categories. Second, the differences presented cannot be attributed solely to population size and geographic location because the analysis intentionally did not control for risk factors. Risk factors do not occur randomly in populations and are related to well-known social, demographic, environmental, economic, and geographic attributes of the neighborhoods in which persons live and work (*17*). Third, trends in potentially excess deaths were estimated using conservative methods that account for the multiple trend lines estimated. Less conservative methods might have identified additional trends in potentially excess deaths by urban-rural county classification that would not have been statistically significant using the more conservative approaches in this report. Fourth, estimates of potentially excess deaths using historical benchmarks (e.g., 2008–2010) might not reflect the progress that could be made in a later year. For example, the estimates of potentially excess deaths from

cancer based on 2010 benchmarks are lower than those based on 2017 benchmarks because of decreases in cancer deaths during 2010–2017. Fifth, changes in the number of potentially excess deaths by cause are not necessarily independent, thus the number of potentially excess deaths from the five causes should not be combined to generate a total. For example, although cancer deaths might have been prevented entirely in certain persons, these persons might have ultimately died from another cause such as heart disease. Finally, defining potentially excess deaths among the five leading causes of death does not account for the complexities in causes of death, which might require different prevention strategies, have varying risk factors, and might vary in availability of interventions. Not all deaths are equally preventable among the leading causes or within each leading cause (e.g., certain types of cancer).

Future Directions

This report demonstrates the value of analyzing potentially excess deaths according to the six 2013 NCHS urban-rural county classifications. Reporting trends in potentially excess deaths over an 8-year period highlights differences over time, independent of traditional underlying structural, environmental, and genetic factors. Because of increasing percentages of potentially excess deaths in recent years for certain causes of death and certain demographic groups, these data can be used, with traditional rate comparisons, by public health practitioners who are involved in planning interventions. Comparing the findings in this report with data from tools such as the CDC Interactive Atlas of Heart Disease and Stroke (https://www.cdc.gov/dhdsp/maps/atlas/index.htm) might help identify the social determinants, health care infrastructures, and public policies that could increase or decrease numbers of deaths in specific nonmetropolitan areas. Detailed community-based case-control studies comparing areas with the highest and lowest death rates might clarify how various risk factors and communitywide social determinants of health affect numbers of deaths in rural and urban areas. In addition, other methods for developing benchmark rates might be helpful, including using benchmarks based on the nonmetropolitan areas with the lowest death rates, alternative approaches for accounting for uncertainty around estimates of potentially excess deaths such as Markov Chain Monte Carlo procedures or bootstrapping, potentially excess deaths among persons aged >80 years, and potentially excess deaths from other causes, especially causes that are more prevalent in nonmetropolitan counties.

Conclusion

Micropolitan and noncore counties have higher percentages of potentially excess deaths from the five leading causes of death compared with metropolitan counties. Routine tracking of potentially excess deaths from the five leading causes of death according to the six 2013 NCHS urban-rural county classifications might help public health officials monitor important health disparities. Such detailed data (e.g., https://tabsoft.co/2BxWUg0) could be used to develop more specific programs and policies that address risk factors and improve the health of residents living in rural counties.

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Conflicts of Interest

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

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