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Rural-Urban Differences in Cardiovascular Mortality in the US, 1999-2017

Wide variation in cardiovascular disease age-adjusted mortality rates (AAMRs) has been noted among counties in the US.[1] Rural residents experience higher death rates compared with residents of urban areas, particularly from potentially preventable causes.[2] We examined temporal trends in cardiovascular disease AAMRs overall and across subgroups stratified by rural-urban area designation in the US.

Methods | We used the US Centers for Disease Control and Prevention Wide-ranging Online Data for Epidemiologic Research (CDC WONDER) database from 1999 to 2017.[3] Based on a report showing that reductions in cardiovascular disease mortality slowed after 2011,[4] we also analyzed trends for 1999-2011 and 2011-2017. The underlying cause of death was determined using the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (codes I00-I99, disorders of the circulatory system) based on death certificate adjudication.

The AAMRs were calculated by multiplying the age-specific death rate for each age group by the corresponding weight from the 2000 standard US population, summing across all age groups, and then multiplying by 100 000.[4] The AAMR is expressed as per 100 000 population per year.

We divided our population using the National Center for Health Statistics urban-rural classification scheme into large metropolitan (≥1 million), medium and small metropolitan (50 000-999 999), and rural (<50 000) counties per the 2013 US Census classification.[5] Because data were publicly available and deidentified, ethics committee approval was not required.

Results were stratified by age (<25, 25-64, and ≥65 years),[6] sex, race, and ethnicity. We used Poisson regression with log link and robust standard errors to estimate annual percentage change (APC) in the AAMR and included an interaction term to test differences in trends over time by urban-rural classification in a second model. Analyses were performed using Stata version 16 (StataCorp). Two-tailed $P < .05$ was considered statistically significant.

Results | Between 1999 and 2017, there were 16 111 775 deaths attributed to cardiovascular disease, with most occurring in large metropolitan areas (n = 7 991 440 [49.6%]) followed

Table. Age-Adjusted Mortality Rates (AAMRs) per 100 000 Population per Year for Cardiovascular Disease in the US, 1999-2017

	Total (N = 16 111 775)					Large metropolitan areas (n = 7 991 440 [49.6%])					Medium and small metropolitan areas (n = 4 946 315 [30.7%])					Rural areas (n = 3 174 020 [19.7%])				
	AAMR			APC (95% CI)[a]		AAMR			APC (95% CI)[a]		AAMR			APC (95% CI)[a]		AAMR			APC (95% CI)[a]	
Characteristics	1999	2011	2017	1999-2011	2011-2017	1999	2011	2017	1999-2011	2011-2017	1999	2011	2017	1999-2011	2011-2017	1999	2011	2017	1999-2011	2011-2017
Overall	350.8	228.6	219.4	-3.8 (-4.0 to -3.6)	-0.6 (-0.9 to -0.4)	347.6	219.3	208.6	-4.1 (-4.3 to -3.9)	-0.7 (-1.0 to -0.4)	343.7	228.4	221.8	-3.7 (-3.9 to -3.5)	-0.5 (-0.7 to -0.2)	371.6	258.1	251.4	-3.2 (-3.4 to -3.1)	-0.3 (-0.5 to -0.2)
Age, y																				
<25	2.7	2.2	2.0	-1.6 (-1.8 to -1.3)	-1.4 (-2.3 to -0.5)	2.6	2.1	1.9	-1.9 (-2.1 to -1.3)	-1.7 (-2.2 to -0.4)	2.5	2.2	2.0	-1.3 (-1.6 to -0.9)	-1.7 (-2.7 to -0.8)	2.9	2.5	2.6	-1.7 (-2.4 to -1.0)	-0.1 (-2.3 to 2.0)[b]
25-64	100.2	77.4	78.5	-2.3 (-2.4 to -2.2)	0.4 (0.2 to 0.5)	96.1	70.4	69.3	-2.7 (-2.8 to -2.6)	-0.2 (-0.4 to 0.1)	99.9	80.3	83.5	-1.9 (-2.1 to -1.8)	0.8 (0.5 to 1.0)	113.5	97.5	104.7	-1.5 (-1.7 to -1.3)	1.3 (1.2 to 1.5)
≥65	2355.6	1483.9	1407.2	-4.1 (-4.3 to -3.9)	-0.8 (-1.1 to -0.5)	2347.2	1439.3	1359.6	-4.3 (-4.5 to -4.1)	-0.8 (-1.2 to -0.5)	2301.0	1470.2	1406.0	-4.1 (-4.3 to -3.8)	-0.7 (-1.1 to -0.4)	2464.7	1633.6	1550.4	-3.6 (-3.7 to -3.4)	-0.8 (-0.9 to -0.6)
Sex																				
Male	420.5	274.6	265.5	-3.8 (-3.9 to -3.6)	-0.5 (-0.7 to -0.3)	415.5	264.2	253.2	-4.0 (-4.2 to -3.8)	-0.7 (-0.9 to -0.4)	411.6	273.8	267.7	-3.7 (-3.9 to -3.5)	-0.4 (-0.6 to -0.2)	4448.6	307.6	302.0	-3.3 (-3.5 to -3.1)	-0.2 (-0.4 to -0.1)
Female	297.9	191.4	181.2	-3.9 (-4.2 to -3.7)	-0.8 (-1.1 to -0.5)	296.8	183.9	172.6	-4.2 (-4.5 to -3.9)	-0.9 (-1.3 to -0.5)	291.5	191.0	183.4	-3.9 (-4.1 to -3.6)	-0.6 (-0.9 to -0.3)	311.8	215.6	206.8	-3.3 (-3.4 to -3.1)	-0.5 (-0.8 to -0.3)
Race[c]																				
White	343.3	224.8	216.5	-3.8 (-4.0 to -3.6)	-0.5 (-0.8 to -0.3)	339.3	215.1	205.4	-4.0 (-4.2 to -3.9)	-0.6 (-1.0 to -0.3)	337.1	224.0	217.7	-3.7 (-3.9 to -3.5)	-0.5 (-0.7 to -0.2)	363.6	253.1	246.6	-3.2 (-3.4 to -3.1)	-0.3 (-0.5 to -0.2)
Black	450.0	291.8	280.0	-3.8 (-4.1 to -3.4)	-0.6 (-0.8 to -0.4)	442.3	281.5	270.0	-3.9 (-4.3 to -3.6)	-0.7 (-0.8 to -0.6)	451.7	300.6	289.9	-3.7 (-4.0 to -3.3)	-0.4 (-0.7 to -0.1)	490.6	335.7	325.4	-3.1 (-3.4 to -2.8)	-0.4 (-0.6 to -0.1)
Asian or Pacific Islander	225.0	136.4	153.9	-4.1 (-4.3 to -3.9)	-1.3 (-1.7 to -0.8)	212.7	132.2	123.4	-3.9 (-4.1 to -3.8)	-1.2 (-1.8 to -0.7)	245.8	148.6	142.3	-4.2 (-4.5 to -3.9)	-1.1 (-1.5 to 0.6)	354.6	162	150.6	-5.0 (-6.9 to -3.0)	-1.7 (-2.6 to -0.8)
Native American/ Alaskan Native	263.7	163.4	153.9	-3.8 (-4.3 to -3.4)	-0.9 (-1.5 to -0.3)	186.6	97.8	98.4	-5.1 (-5.9 to -4.3)[b]	-0.1 (-0.8 to 0.7)	235.7	164.2	156.5	-3.2 (-3.6 to -2.9)	-0.5 (-1.1 to 0.1)[b]	351.2	240.9	220.1	-2.9 (-3.8 to -2.0)	-1.4 (-2.6 to -0.1)
Ethnicity																				
Non-Hispanic	353.7	233.3	225.0	-3.7 (-3.9 to -3.5)	-0.5 (-0.8 to -0.3)	351.6	224.5	214.6	-4.0 (-4.2 to -3.8)	-0.6 (-1.0 to -0.3)	346.2	232.0	226.5	-3.6 (-3.9 to -3.4)	-0.4 (-0.6 to -0.1)	371.9	260.6	254.4	-3.2 (-3.3 to -3.0)	-0.3 (-0.5 to -0.1)
Hispanic[c]	269.0	167.4	158.9	4.0 (-4.3 to -3.7)	-0.8 (-1.0 to -0.6)	266.5	165.8	157.2	-4.0 (-4.3 to -3.7)	-0.8 (-1.0 to -0.6)	264.0	170.3	161.0	-3.7 (-4.0 to -3.3)	-0.8 (-1.1 to -0.6)	308.9	173.5	168.9	-4.6 (-5.1 to -4.2)	-0.7 (-1.1 to -0.3)

Abbreviation: APC, annual percentage change.

[a] The majority were statistically significant at $P < .05$.

[b] Not statistically significant.

[c] Information was reported by the funeral director on the basis of observation or had been provided by the next of kin or another close contact.

by medium and small metropolitan areas (n = 4 946 315 [30.7%]), and rural areas (n = 3 174 020 [19.7%]) (**Table**). The total AAMR declined from 350.8 in 1999 to 219.4 in 2017. Rural areas had consistently higher AAMRs than nonrural areas in all subgroups. In all regions, black people had higher AAMRs than other races and males had higher AAMRs than females. In addition, non-Hispanic people had higher AAMRs than Hispanic people.

From 1999 to 2011, the APC in the AAMR was −4.1% (95% CI, −4.3% to −3.9%) in large metropolitan areas, −3.7% (95% CI, −3.9% to −3.5%) in medium and small metropolitan areas, and −3.2% (95% CI, −3.4% to −3.1%) in rural areas. Between 2011 and 2017, the APC in the AAMR was −0.7% (95% CI, −1.0% to −0.4%) in large metropolitan areas, −0.5% (95% CI, −0.7% to −0.2%) in medium and small metropolitan areas, and −0.3% (95% CI, −0.5% to −0.2%) in rural areas.

Although most subgroups experienced a decline in the AAMR throughout the study, there were notable exceptions. Between 2011-2017, the AAMRs significantly increased among those aged 25 to 64 years living in medium and small metropolitan areas (0.8% [95% CI, 0.5% to 1.0%]) and in rural areas (1.3% [95% CI, 1.2% to 1.5%]).

Trends over time were significantly different for rural areas vs large metropolitan areas ($P < .001$). The AAMRs declined more slowly in rural areas, resulting in a widening disparity between regions. The absolute difference in the AAMRs between large metropolitan areas and rural areas in 1999 was 24.0 deaths per 100 000 population (95% CI, 22.1 to 25.9), which increased in 2017 to 42.8 deaths per 100 000 population (95% CI, 41.5 to 44.2).

Discussion | Between 1999 and 2017, rural areas exhibited greater cardiovascular disease AAMRs among all subgroups, with the absolute difference between rural areas and large metropolitan areas nearly doubling over time. The increase in cardiovascular disease AAMRs among middle-aged individuals in medium and small metropolitan and in rural areas beginning in 2011, in addition to drug overdoses and suicide, may be contributing to reductions in life expectancy.[6] This disparity is likely driven by a combination of demographic changes, the economic slowdown, the high prevalence of cardiovascular disease risk factors, and poorer access to health care.

Limitations include possible errors in documentation of race/ethnicity and cause of death on death certificates. Further research is needed to elucidate reasons for the gaps in cardiovascular disease AAMRs between urban and rural areas and the rising death rates among middle-aged individuals to inform policies and programs targeting this disparity.

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