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The Gap Gets Bigger: Changes in Mortality and Life expectancy by Education, 1981–2000

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Abstract

Reducing health disparities in the United States has been targeted by numerous policies. We examine educational disparities in mortality and life expectancy among non-Hispanic blacks and whites in the 1980s and 1990s. Despite increased attention and substantial dollars directed to groups with low socioeconomic status, within race and sex groups, the educational gap in life expectancy is rising, mainly due to rising differentials among the elderly. With the exception of black males all recent gains in life expectancy at age 25 occurred among better educated groups, raising educational differentials in life expectancy by 30 percent. Differential trends in smoking-related diseases explain at least 20 percent of this trend.

Disparities in mortality and morbidity across educational groups in the United States have been prevalent for decades. Attention to these disparities intensified with Kitagawa and Hauser's comprehensive national account of educational mortality differentials in 1973,¹ and a wave of related disparities research followed.² Heartened by early successes in the Healthy People 2000 initiative to reduce disparities in health care and health outcomes, the Healthy People 2010 initiative aims to eliminate health disparities entirely by the end of this decade. Groups such as the Institute of Medicine and many private organizations have also promoted this agenda.³ In 2003, the Agency for Health Care Research and Quality produced its first annual National Healthcare Disparities Report to track racial and socioeconomic disparities in health and health care.⁴

Several health interventions have been designed to address racial and socioeconomic disparities in health. Well-known examples include the Disproportionate Share Program (\$12.9 billion annually)⁵ and the State Children's Health Insurance Programs and related Medicaid expansions (\$7 billion annually). In addition, much of the \$6.6 billion annual budget for the Health Resources and Services Administration (HRSA) targets disadvantaged populations via funding for community health centers and the Ryan White Care program for HIV/AIDS. The current wave of state initiatives to expand health insurance coverage explicitly targets low-SES children and adults. Finally, efforts to improve public health promotion and disease prevention activities have expanded over time, with a particular focus on risk factors that are prevalent among populations with low socioeconomic status: tobacco use, obesity, and under-use of prevention and screening services.⁶

Recent research on racial disparities demonstrates mortality gains for blacks relative to whites during the 1990s⁷, but data on educational disparities in health are not comprehensive. Most research measuring educational health disparities ends in the 1980s. These studies show widening differences in mortality by education.⁸ Many of the programs noted above post-date that era, however. More recent evidence focuses on area-level disparities.⁹ But, significant migration and demographic change means that area-level analyses may understate or overstate the full extent of health disparities at the individual-level.¹⁰ Another large study after 1990 pools data from 1959 through 1996, making it difficult to attribute trends to a single decade.¹¹ Furthermore, analyses of death by cause can augment our understanding of educational disparities in mortality because some causes of death are more amenable to intervention than others, suggesting different policy approaches to ameliorate disparities.¹²

We analyzed life expectancy and mortality trends by education group, and then estimated which diseases account for differential trends in mortality.

DATA AND METHODS

Sources of data

We used two different sources of data to estimate mortality trends. We matched Census population estimates to death certificate data in the Mortality, Multiple-Cause-of-Death (MCD) files for 1990 and 2000.¹³ The nearly universal sample of deaths makes the MCD attractive, but there are questions about the accuracy of education reporting on death certificates.¹⁴ To validate these data and to assess an earlier time period, we used the National Longitudinal Mortality Study (NLMS), which followed members of the March Current Population Survey (CPS) through subsequent deaths. The CPS data span years 1981–85 and 1991–95, and deaths span 1981–1988 and 1991–1998.¹⁵ The initial CPS sample is non-institutionalized. For this reason, mortality rates in the NLMS are below those in the MCD, which includes all deaths. We restricted analyses to non-Hispanic blacks and whites to limit the impact of immigration on our estimates. The Appendix summarizes the data and sample characteristics.

Measures of education

Survey respondents in the NLMS and Census respondents report education, while informants, usually next of kin, report education on death certificates. Previous studies document some inconsistencies between these methods, in particular overstatement of high school graduation relative to incomplete high school experience on death certificates.¹⁶ As a result, we chose two broad categories of education where agreement is high. Low-education refers to “12 or fewer years of education” and high education indicates at least 13 years of schooling. This cutoff yields the following shares of high-education individuals in our study: 47.3% in 1990 and 54.5% in 2000 using Census data, and 43.9% in 1981–1988 and 56.1% in 1991–1998 in the NLMS.

Because rising educational attainment over time could affect our results, we re-computed estimates after equalizing the share of individuals in the high and low education groups. We did this by randomly reassigning some individuals with 12 years of education to the high education group in the early period to match education shares in the latter period. The patterns we document are robust to the changing composition within education groups (Appendix Table A6).

Mortality rates and Life Expectancy

For a given age-race-sex-education group (e.g. white low-education women aged 65–74 in 1990), we divided the number of deaths by the group's population to compute age-specific mortality rates. These were calculated for ages 25–84 since most education is completed by 25, and few NLMS participants survived beyond 84. To incorporate mortality after age 84, we assigned published death rates within age-sex-race groups.¹⁷ Period life expectancy is then constructed in the usual fashion. Details regarding the mortality and life expectancy estimates are available in the appendix.

Cause-specific mortality rates

For 1990 and 2000 we estimated cause-specific mortality rates based on the five leading causes of death: diseases of the heart, cancers, cerebrovascular diseases, chronic obstructive pulmonary disease (COPD), and unintentional injuries.¹⁸ Because ample evidence implicates tobacco use as the underlying cause for a substantial portion of deaths,¹⁹ we distinguished lung from other cancers, yielding six cause-of-death categories.²⁰

Analyses

We computed life expectancy by education both within race-sex groups and for the entire study population, holding the race and sex composition constant at year 2000 shares. We also calculated age-standardized mortality rates using 10-year age strata with the year 2000 population standard. The changes in these rates from 1990 to 2000 were decomposed by cause of death and age group, as described in the Appendix. We computed standard errors for 1990, 2000, and changes over time using the Delta Method, and NLMS variance estimates accounted for the complex survey design.²¹ Lastly, given the importance of causes of death for which smoking is a risk factor, we computed the sex-specific, age-adjusted share of the adult population (25 and older) reporting they were “current smokers” for selected years between 1966 and 2002, in various annual National Health Interview Surveys.²²

RESULTS

Life Expectancy

Between the 1980s and 2000, life expectancy increases occurred nearly exclusively among high-education groups (Exhibit 1). Comparing 1981–88 with 1991–98, life expectancy at age 25 grew 1.4 years for high education individuals, but only 0.5 years for less educated individuals, a 0.9 year difference ($p = 0.014$). Between 1990 and 2000, life expectancy grew 1.6 years for the high education group, but remained unchanged for the low education group ($p < .001$ for the difference). As expected, life expectancy in the MCD data was lower than in the NLMS because of the inclusion of the institutionalized population. In both datasets, educational gaps in life expectancy increased by about 30%. This similarity is striking given the differences in sampling frame and education measures between the sources.

Further, the levels of the education differences are large. In 2000, life expectancy for a 25 year-old with a high school degree or less was 50 years. For a person with some college, life expectancy was nearly 57 years.

Life expectancy by race and sex

Widening educational disparities in life expectancy do not arise from increased racial or gender differences in mortality trends. Our population estimates hold demographics constant at their 2000 level. More fundamentally, Exhibit 2 shows similar trends within each race and sex group. The growing educational gap in life expectancy is most pronounced among women, regardless of race. Life expectancy at age 25 *declined* among less-educated black and white women, while rising 1 year or more for more educated women. By the year 2000, highly educated women could expect to live over five years longer than their lesser educated counterparts, in both races. For white men the gap was 7.8 years in 2000, up 1.6 years from 1990, and for black men it was 8.4 years, up by 1.3 years.

Overall, and even within-race trends in mortality by education mask another important trend. Although SES differences in mortality were rising, mortality differences across genders and races were falling. From 1990 to 2000, the life expectancy differences between blacks and whites decreased by 1.8 years for low-education males, by 1.5 years for high-education males, and by 0.7 and 0.6 years for low- and high-education females. Life expectancy for low-education white males increased in both the NLMS and MCD data while it decreased for females. Within the high-education group, life expectancy increased for both men and women, but the gains for men were almost double that for women. Racial and gender gaps in mortality persist, but they are smaller now than they were in the 1980s.

Cause-specific Contributors to Rising Education Differentials

Diseases of the heart, cancers, and COPD contributed over 60% of deaths in the sample in 1990 and 2000 in all race and sex groups. Exhibit 3 shows the contribution of each cause to the increase in educational mortality gaps. Diseases of the heart and cancers excluding lung cancer contributed most to rising education differentials, 32%. Lung cancer and COPD, two diseases largely attributable to tobacco use, accounted for another 21%. These diseases were particularly salient among less educated white women over the age of 45, among whom lung cancer and COPD contributed about 25% of rising educational gaps in mortality (Appendix Table A7). Exhibit 4 shows that by the year 2000, lung cancer and COPD death rates were twice as high among low education white men and women and black men, compared to the more educated in these groups.

Age-specific Contributors to Rising Education Differentials

Increased education differentials among the elderly account for much of the growing gaps in mortality and life expectancy. Within each race-gender group, at least half of the growth in life expectancy gaps and over 60% of the growth in mortality gaps come from individuals aged 65 or older (Appendix Tables A8-A9). In contrast, trends among adults aged 25–44 contributed little to growing gaps in mortality, and among young black men aged 25–44, educational mortality gaps narrowed from 1990–2000. Among the causes of death we examined, the narrowing educational differential among black men aged 25–44 was driven by unintentional injuries and heart disease deaths (Appendix Table A7).²³

Smoking rates over time

Adult smoking rates have declined significantly since the mid 1960s (exhibit 5). Among men, the reduction in smoking prevalence was relatively even by education, though somewhat greater for the better educated. Between 1966 and 1995, rates dropped 22 percentage points among the better educated versus 18 percentage points among less educated men, despite the fact that better educated men already had lower smoking rates in 1966.

Smoking among women increased from 1965 through the late 1970s, and then began to decline. The decline from 1979 through 1995 was 12 percentage points among the better educated and 5 percentage points among the less educated. Interestingly, the sharp divergence in smoking rates by education occurred between 1979 and 1983, coincident with the first Surgeon General's Report highlighting smoking risks for women. Over the entire time period, smoking among female college attendees declined by over 16 percentage points, compared with only 7.5 percentage points among less educated women.

DISCUSSION

The 1980s and 1990s were periods of rapidly rising life expectancy, but the mortality declines that yielded these gains did not occur evenly by educational group. On average, we find very little change in life expectancy among less educated black and white non-Hispanics, and very substantial increases in life expectancy among the more educated. These patterns mirror similar widening of education differentials in disability and self-reported health status over the same period.²⁴ The growing gap in life expectancy by education occurred during a period of increasing attention to health disparities and increased public spending designed to improve the health of less advantaged populations.

One important exception to this pattern is that educational mortality disparities narrowed among young black men, a finding consistent with recent evidence that racial mortality gaps narrowed in the 1990s. Nevertheless, a 5 year gap in life expectancy between blacks and whites

remains.²⁵ Across sex groups, men made faster gains in mortality than women over this period, narrowing mortality and life expectancy gaps by sex.

Our data span a period of rapidly rising income inequality, providing one potential explanation for widening educational disparities. However, data do not support this explanation because health disparities narrowed across race and gender as inequality increased.²⁶

Our results suggest that differential trends in smoking may explain a significant part of widening gaps in mortality and life expectancy. The diseases contributing most to the growing educational gap in mortality include diseases of the heart, lung and other cancers, and COPD, all of which share tobacco use as a major risk factor. Lung cancer and COPD alone account for one quarter of the increasing gap in life expectancy for women over 45, consistent with their sharp divergence in smoking rates during the 1980s. For men, the divergence in smoking was more moderate, as was the increase in the mortality gap attributable to tobacco-related causes of death.

Public policy designed to reduce health consequences related to smoking may have indirectly contributed to this disparity. In the half century since the harms of smoking became widely known, tobacco control measures have proliferated. Cigarette labels warning of the health hazards of smoking have been required since 1966. Cigarette advertising was banned from television and radio in 1971.²⁷ During the 1980s and 1990s, many states and localities instituted smoking bans in the workplace. By 1993, 70% of indoor workers had smoking bans in work,²⁸ and by 2007, every state had some smoke free air provision.²⁹ In addition, cigarette taxes have increased rapidly in recent years, after falling in real terms in the 1970s. On net, the real price of cigarettes has nearly tripled since the 1960s.³⁰

The proliferation of tobacco control policies brought remarkable reductions in tobacco use. In the four decades following the 1964 Surgeon General's report, per capita annual consumption of cigarettes among adults fell by half. However, declines were greatest among the most educated groups. The growing gap in mortality by education for smoking-related causes supports the longstanding paradox that attention to prevention can widen disparities in health across education and income groups.³¹ In this case, the advances related to knowledge about risk factor control; we cannot say whether the same is true about medical technologies.³²

The focus on tobacco does not imply that other efforts to reduce disparities in health were not successful. Indeed, we confirm recent work highlighting relative gains in life expectancy overall for blacks compared with whites during the 1990s.³³ Further, other studies have shown that Medicaid expansions targeting low-income pregnant women and children improved health outcomes among these populations.³⁴ Our study does not argue that these policies were unsuccessful. Rather, it suggests that these efforts were swimming against a strong tide, one which overwhelmed billions of dollars spent annually on additional medical care. On the more positive note, our results suggest that one place to look for real progress is tobacco control efforts for low SES groups because mortality trends mimic trends in smoking that occurred decades earlier. These long-run consequences of health behaviors bolster the argument for early childhood intervention.³⁵

The explanation for differential smoking trends is complex. Basic knowledge does not appear to be the major issue. In 1986, 90% of Americans surveyed across the board reported that smoking causes lung cancer and emphysema, and 80% believed it contributed to heart disease and bronchitis.³⁶ Translating knowledge into action has proven more complex, however. Innovations that target less-advantaged groups might offset this unintended consequence of medical progress. Some caution about this conclusion is needed, however. Without addressing the underlying factors that lead less educated individuals to be less able or willing to invest in

better health, measures to reduce smoking may simply lead to a shift from tobacco-related deaths to other causes.³⁷

Beyond the differential change in smoking, there is the national trend towards increased obesity. As with smoking, obesity is more common among the less educated than among the better educated. Further, recent research suggests that obesity might contribute to nearly as many deaths as tobacco.³⁸ Although the population health consequences of obesity remain controversial, the obesity trends in recent years and into the future could further widen socioeconomic gaps in health.

In summary, during a period of increased focus on disparities in health, virtually all gains in life expectancy occurred among highly educated groups. Causes of death related to differential trends in cigarette smoking by education have contributed substantially to rising mortality differentials. Larger and better targeted efforts to push successful health interventions into less educated groups may be needed to achieve the goal of reducing disparities in health by socioeconomic group.

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NOTES

1. Kitagawa, EM.; Hauser, PM. Differential Mortality in the United States: A Study in Socioeconomic Epidemiology. Harvard University Press; Cambridge, MA: 1973.
2. U.S. Department of Health and Human Services. Report of the Secretary's Task Force on Black & Minority Health. Health Status of Minorities and Low-Income Groups. U.S. Department of Health and Human Services.. , editor. Washington, D.C.: 1985. (Hyattsville, Maryland: 1985)
3. Institute of Medicine. Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. In: Smedley, BD.; Stith, AY.; Nelson, AR., editors. National Academies Press; 1–764. Washington, D.C.: 2003. U.S. Department of Health and Human Services, Healthy People 2010: Understanding and Improving Health (Washington, D.C.: Government Printing Office, 2000)
4. Healthcare Research and Quality Act of 1999. p. 106-129.
5. Centers for Medicare & Medicaid Services. Medicaid Program - General Information, Technical Summary. 2005 [March 28, 2006].
http://www.cms.hhs.gov/MedicaidGenInfo/03_TechnicalSummary.asp
6. Institute of Medicine. The Future of the Public's Health in the 21st Century. National Academies Press; Washington, D.C.: 2003.
7. Harper S, et al. Trends in the Black-White Life Expectancy Gap in the United States, 1983–2003. *Journal of the American Medical Association* 297:1224–1232. Murray CJL, et al. Eight Americas: Investigating Mortality Disparities across Races, Counties, and Race-Counties in the United States. *PLoS Medicine* 2006;3(9):e260. [PubMed: 16968116]
8. Crimmins EM, Saito Y. Trends in Healthy Life Expectancy in the United States, 1970–1990: Gender, Racial, and Educational Differences. *Social Science and Medicine* 52(2001):1629–1641. Lin CC, et al. A Further Study of Life Expectancy by Socioeconomic Factors in the National Longitudinal Mortality Study. *Ethnicity & Disease* 2003;13:240–247. [PubMed: 12785422] Spring 2003 Pappas MDG, et al. The Increasing Disparity in Mortality between Socioeconomic Groups in the United States, 1960 and 1986. *New England Journal of Medicine* 1993;329(2):103–109. [PubMed: 8510686] Feldman JJ, et al. National Trends in Educational Differentials in Mortality. *American Journal of Epidemiology* 1989;129(5):919–933. [PubMed: 2705434]
9. Singh GK, Siahpush M, Murray CJL, et al. Widening Socioeconomic Inequalities in Us Life Expectancy, 1980–2000. *Eight Americas: Investigating Mortality Disparities across Races, Counties,*

- and Race-Counties in the United States”. International Journal of Epidemiology PLoS Medicine 2006;2006;3(9):e260. See the area-level analyses
10. Steenland K, et al. All-Cause and Cause-Specific Death Rates by Educational Status for Two Million People in Two American Cancer Society Cohorts, 1959–1996. American Journal of Epidemiology 156(1)(2002):11–21. [PubMed: 12076884]
 - 11.
 12. Wong, et al. Contribution of Major Diseases to Disparities in Mortality. New England Journal of Medicine 347(20)(2002):1585–1592.
 13. Mortality Data. Ruggles, S., et al. Multiple Cause-of-Death Public-Use Data Files. Integrated Public Use Microdata Series: Version 3.0 [Machine-Readable Database]. National Center for Health Statistics; Hyattsville, MD: 2004 [June 28, 2007]. <http://www.ipums.org>
 14. Sorlie PD, Johnson NJ. Validity of Education Information on the Death Certificate. Epidemiology 7 (1996):432–439.
 15. Rogot, E., et al. A Mortality Study of One Million Persons by Demographic, Social and Economic Factors: 1979–1981 Follow-Up. In: National Institutes of Health. , editor. National Institutes of Health; Bethesda, MD: 1988.
 16. Sorlie and Johnson, “Validity...”.
 17. Arias E. United States Life Tables, 2002 National Vital Statistics Reports 53(6)(2004):1–39.
 18. National Center for Health Statistics. Health, United States, 2003. Hyattsville; Maryland: 2003. p. 144
 19. For lung cancer, as for COPD, the smoking attributable fraction of deaths exceeds 80%. U.S. Department of Health and Human Services, “The Health Consequences of Smoking: A Report of the Surgeon General,” edited by Centers for Disease Control and Prevention and Health Promotion. Office on Smoking and Health; Washington, DC: 2004.
 20. McGinnis JM, Foege WH. Actual Causes of Death in the United States. JAMA 1993;270(18):2207–2212. [PubMed: 8411605] Mokdad AH, et al. Actual Causes of Death in the United States, 2000. JAMA 2004;291(10):1238–1245. [PubMed: 15010446]
 21. Oehlert GW. Note on the Delta Method. American Statistician 46(1992):27–29.
 22. Dept, US. National Health Interview Survey, various years. National Center for Health Statistics; Hyattsville, MD: of Health and Human Services
 23. Harper, et al. Black-White Life Expectancy. documents declining unintentional injury deaths among young black men, as well as significant drops in HIV deaths and homicides
 24. Schoeni RF, et al. Goesling B. Persistent and Growing Socioeconomic Disparities in Disability Among the Elderly: 1982–2002. The Rising Significance of Education for Health? American Journal of Public Health Social Forces 2005;95(11):2065–2070. [PubMed: 16254235] forthcoming
 25. Harper, et al. Black-White Life Expectancy.
 - 26.
 27. U.S. Department of Health Education and Welfare. Smoking and Health: Report of the Advisory Committee to the Surgeon General of the Public Health Service. Education, Information and Smoking Decisions: Evidence from Smoking Histories, 1940–2000. In: Public Health Service, 1–387: U.S. Department of Health, Education, and Welfare. DeWalque, D., editor. Policy Research Working Paper. World Bank; Washington, D.C.: 1964. 2004.
 28. Evans WN, et al. Do Workplace Smoking Bans Reduce Smoking? American Economic Review 1999;89(5):729–747.
 29. American Lung Association. Smoking Policies in the Workplace Fact Sheet. Aug2006 [February 5 2007]. <http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=36000>
 30. Orzechowski, W.; Walker, RC. The Tax Burden on Tobacco: Historical Compilation. 39. Arlington, VA: 2004.
 31. Susser, M., et al. Sociology in Medicine. Oxford University Press; New York: 1985.
 32. Link BG, Phelan JC. Mckeown and the Idea That Social Conditions Are Fundamental Causes of Disease. American Journal of Public Health 2002;92(5):730–732. [PubMed: 11988436]
 33. Harper; et al. Murray, et al. Trends in the Black-White Life Expectancy Gap. Eight Americas.

34. Currie J, Gruber J. Saving Babies: The Efficacy and Cost of Recent Medicaid Expansions of Eligibility for Pregnant Women. *Journal of Political Economy* 1996;104(6):1263–1296.
35. Heckman, J.; Masterov, D. The Productivity Argument for Investing in Young Children. National Bureau of Economic Research; Cambridge, MA: Working Paper #13016, 2007
36. U.S. Department of Health Education and Welfare. The Health Consequences of Smoking. p. 171-258.
37. Link; Phelan. McKeown.
38. Mokdad; et al. Olshansky, et al. Actual Causes of Death; A Potential Decline in Life Expectancy in the United States in the 21st Century; *New England Journal of Medicine*. 2005. p. 1138-1145. Flegal KM, et al. Excess Deaths Associated with Underweight, Overweight, and Obesity. *Journal of the American Medical Association* 293(15):1861–1867.

EXHIBIT 1. Life Expectancy at Age 25 by Education

Source: Authors' calculations based on non-Hispanic blacks and whites in the National Longitudinal Mortality Study and Multiple-Cause-of-Death Data.

Exhibit 3. Contribution to growth in educational disparities in mortality by cause of death 1990–2000, ages 25–84

Source: Authors' calculations with data on non-Hispanic blacks and whites in the Multiple Cause of Death Files and IPUMs, 1990 and 2000.

EXHIBIT 5. Smoking Rates* By Education, 1965 – 2003

Source: National Health Interview Surveys, various years. * Smoking rates are age-standardized to the 1990 population standard.

Exhibit 2

Life Expectancy at Age 25

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Race, Sex, and Education Group	National Longitudinal Mortality Study			Death Certificates/Census		
	1981–88	1991–98	Change	1990	2000	P-value
White men						
All	49.8	51.5	1.7	49.6	51.0	<.001
Low education	48.6	49.6	1.0	47.1	47.1	<.001
High education	52.2	54.0	1.8	53.2	55.0	<.001
Difference	3.6	4.4	0.9	6.2	7.8	<.001
White women						
All	56.3	56.6	0.4	55.6	55.8	<.001
Low education	55.9	55.7	–0.3	54.3	53.4	<.001
High education	57.3	58.1	0.9	57.8	58.8	<.001
Difference	1.3	2.5	1.1	3.5	5.4	<.001
Black men						
All				42.4	44.9	<.001
Low education				40.2	42.3	<.001
High education				47.3	50.6	<.001
Difference*				7.1	8.4	<.001
Black women						
All				50.6	51.2	<.001
Low education				49.4	49.2	.053
High education				52.9	54.6	<.001
Difference				3.6	5.4	<.001

Source: Author calculations using data on non-Hispanics in the National longitudinal Mortality Study and Death certificate data from the Multiple Cause of Death Files and the Integrated Public Use Micro Sample of the 2000 Decennial census

* Estimates among black population in National Longitudinal Mortality Study are not shown because they are unreliable due to small numbers within subgroups.

Exhibit 4

Age-Standardized Deaths per 100,000 by Education, Race, Sex, and Cause*

Race, Sex, & Cause	Low education		High education		Differential Change [†]	P-value
	1990	2000	1990	2000		
White men						
All	1593	1574	944	774	151	<.001
Diseases of the heart	543	465	320	226	16	<.001
Cancers, except lung	261	265	194	167	32	<.001
Lung cancer	162	158	77	63	10	<.001
COPD [‡]	86	96	40	36	15	<.001
Cerebrovascular dis.	76	74	50	42	6	<.001
Unintentional injury	79	87	32	32	8	<.001
White women						
All	885	941	580	504	163	<.001
Diseases of the heart	259	231	159	111	19	<.001
Cancers, except lung	199	199	159	132	27	<.001
Lung cancer	65	84	42	41	19	<.001
COPD [‡]	42	65	28	31	20	<.001
Cerebrovascular dis.	60	60	43	35	8	<.001
Unintentional injury	27	35	17	16	8	<.001
Black men						
All	2321	2129	1537	1166	179	<.001
Diseases of the heart	676	579	478	338	43	.009
Cancers, except lung	394	366	308	238	42	<.001
Lung cancer	209	183	123	86	10	.164
COPD [‡]	69	70	45	32	13	.003
Cerebrovascular dis.	143	128	96	72	9	.197
Unintentional injury	113	99	51	44	-6	.111
Black women						
All	1246	1285	969	816	192	<.001
Diseases of the heart	404	360	301	229	29	.003
Cancers, except lung	242	236	242	187	49	<.001
Lung cancer	60	70	47	44	13	<.001
COPD [‡]	25	35	18	22	6	.004
Cerebrovascular dis.	104	96	84	64	12	.014
Unintentional injury	33	35	24	18	7	.002

* Age-standardized deaths among 25 to 84 year olds using year 2000 standard. Note that data exclude non-Hispanics.

[†] Differential decrease in deaths for high v. low-education = (1990 death rate - 2000 death rate)/High education - (1990 death rate - 2000 death rate)/Low education[‡] COPD - Chronic Obstructive Pulmonary Diseases