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Brief Communication

BRIEF COMMUNICATION

Temporal Trends in Mortality From Major Cancers by Education in the United States, 2001–2016

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Abstract

Data on recent trends in mortality from major cancers by individual-level socioeconomic status are lacking in the United States. We examined mortality trends and disparities by educational attainment (rate ratio ≤12 vs ≥16 years of education) from 2001 to 2016 for lung, colorectal, female breast, and prostate cancers among individuals ages 25–74 years. During 2001–2016, death rates continued to decrease in each stratum of sex and education categories for all four cancers, with the steepest decline among those with at least 16 years of education. Consequently, relative educational disparities widened over time. Among men, for example, lung cancer death rates from 2001 to 2016 decreased 2.70% per year in persons with 12 years or less of education compared with 5.44% per year among those with at least 16 years of education, and the rate ratio increased from 2.96 (95% CI = 2.84 to 3.09) to 4.58 (95% CI = 4.41 to 4.76). Enhanced interventions targeting low–socioeconomic status populations are needed to reduce the inequality and accelerate progress against cancer.

Deaths from cancers of the lung and bronchus, colon and rectum, female breast, and prostate account for nearly one-half of the total cancer deaths in the United States (1). Understanding contemporary temporal trends in death rates from these major cancers by socioeconomic status (SES) is important for reducing the burden of these diseases and cancer burden as a whole. We previously examined trends in death rates from these four major cancers by educational attainment from 1993 to 2001 among working-aged adults and found that the decreases in death rates were confined to highly educated persons (2). A recent study found that area-level socioeconomic disparities in cancer mortality widened because of slower decreases in mortality in lower SES areas (3). However, there have been no studies, to our knowledge, examining recent trends in cancer mortality from these major cancers by individual-level SES. Herein, we extended our previous study by examining contemporary trends by individual-level educational attainment as a marker of SES to assess whether individual-level socioeconomic disparities have changed during the most recent time period.

Mortality data for 2001–2016 were obtained from the National Center for Health Statistics (4). Underlying causes of death were classified according to the coding and selection rules of the 10th revision of the *International Classification of Diseases* (5). Specifically, lung and bronchus (lung) cancer was identified by the 10th revision of *International Classification of Diseases* code C34, colon and rectum cancer (colorectal) was identified by codes C18–C20 and C26, breast cancer was identified by code C50, and prostate cancer was identified by code C61. Corresponding population denominator data were obtained from the public-use microdata sample files of the American Community Survey (6). This study is exempted from institutional review board review because all analyses were based on deidentified, publicly available data.

Annual age-standardized death rates for all four major cancers were first calculated by sex and educational attainment (≤12, 13–15, and ≥16 years of education) based on the 2000 US standard population using SAS version 9.4. Average annual percent changes in age-standardized death rates from 2001 to 2016 were then estimated by sex, education, and cancer site using joinpoint regression with a maximum of two joinpoints allowed. Mortality rate ratios (RRs) and rate differences (RDs) comparing 12 or fewer years of education with at least 16 years were calculated to express relative and absolute educational disparities in death rates, respectively. Linear trends in the RRs

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Table 1. Age-standardized cancer death rates (100 000) from common cancers by sex and educational attainment, 2001 and 2016

	Men				Women			
Cancer site	2001	2016	AAPC	P†	2001	2016	AAPC	P†
Lung and bronchus								
All education, y	76.0	42.1	−3.75	<.001	44.8	29.7	−2.60	<.001
≤12	109.5	70.9	−2.70	<.001	58.0	46.0	−1.47	<.001
13–15	48.0	30.2	−2.86	<.001	29.7	22.6	−1.74	<.001
≥16	36.9	15.5	−5.44	<.001	25.7	13.3	−4.07	<.001
RR* (95% CI)	2.96 (2.84 to 3.09)	4.58 (4.41 to 4.76)		<.001	2.26 (2.15 to 2.37)	3.47 (3.34 to 3.61)		<.001
RD* (95% CI)	72.5 (70.1 to 75.0)	55.5 (54.0 to 56.9)		<.001	32.3 (30.8 to 33.9)	32.7 (31.8 to 33.7)		.239
Colon and rectum								
All education, y	21.0	15.2	−2.26	<.001	14.0	10.1	−2.11	<.001
≤12	26.6	21.4	−1.52	<.001	16.8	13.3	−1.50	<.001
13–15	14.3	12.1	−1.15	<.001	9.7	8.5	−1.03	<.001
≥16	16.3	9.9	−3.41	<.001	11.4	7.4	−2.94	<.001
RR* (95% CI)	1.64 (1.56 to 1.72)	2.17 (2.07 to 2.27)		<.001	1.47 (1.38 to 1.56)	1.81 (1.72 to 1.90)		<.001
RD* (95% CI)	10.3 (9.4 to 11.3)	11.5 (10.9 to 12.2)		.435	5.4 (4.6 to 6.1)	6.0 (5.5 to 6.4)		.066
Breast								
All education, y	—	—	—	—	30.5	22.3	−2.11	<.001
≤12	—	—	—	—	34.3	26.0	−1.88	<.001
13–15	—	—	—	—	23.7	20.9	−1.19	<.001
≥16	—	—	—	—	30.2	21.1	−2.64	<.001
RR* (95% CI)	—	—	—	—	1.14 (1.09 to 1.18)	1.29 (1.25 to 1.34)		<.001
RD* (95% CI)	—	—	—	—	4.1 (2.8 to 5.4)	5.9 (5.1 to 6.7)		.004
Prostate								
All education, y	12.1	8.7	−2.31	<.001	—	—	—	—
≤12	14.6	11.5	−1.81	<.001	—	—	—	—
13–15	8.1	7.3	−0.99	<.001	—	—	—	—
≥16	10.1	6.5	−2.89	<.001	—	—	—	—
RR* (95% CI)	1.45 (1.35 to 1.55)	1.76 (1.66 to 1.86)		<.001	—	—	—	—
RD* (95% CI)	4.5 (3.7 to 5.3)	4.9 (4.5 to 5.4)		.683	—	—	—	—

*Rate ratio and rate difference comparing fewer than or equal to 12 years of education with greater than or equal to 16 years of education. AAPC = average annual percent change; CI = confidence interval; RD = rate difference; RR = rate ratio.

†Value adjacent to AAPC indicates test for AAPC statistical difference from 0, two-sided. Value adjacent to RRs or RDs indicates test for trend in RRs or RDs from 2001 through 2016.

and RDs from 2001 to 2016 were tested using weighted linear regression with the inverse variance of the estimated RRs and RDs being used as weight. In supplemental analysis, we performed similar analyses by census region (Northeast, Midwest, South, and West) and by race or ethnicity (non-Hispanic white, non-Hispanic black, and Hispanics). All tests were two-sided with a statistical significance level of *P* less than .05.

Death rates continued to decrease from 2001 to 2016 among each stratum of the sex and education categories for all four cancer sites, with the decreases steeper among persons with at least 16 years of education than among those with lower educational attainment (Table 1; Figure 1). For example, the lung cancer death rate among persons with 12 or fewer years of education decreased 2.70% per year among men and 1.47% per year among women during 2001–2016. In contrast, the corresponding annual percent decline among those with at least 16 years of education was 5.44% for men and 4.07% for women. Similar differential mortality trends by education were found for colorectal cancer, female breast cancer, and prostate cancer. Consequently, the educational disparities, as measured by RRs comparing death rates between 12 or fewer years of education and at least 16 years, increased during 2001–2016 for all four major cancers. Especially, the RR for lung cancer increased from 2.96 (95% confidence interval [CI] = 2.84 to 3.09) to 4.58 (95% CI = 4.41 to 4.76) in men and from 2.26 (95% CI = 2.15 to 2.37) to 3.47 (95% CI = 3.34 to 3.36) in women; the RR for colorectal cancer increased from 1.64 (95% CI = 1.56 to 1.72) to 2.17 (95% CI = 2.07 to 2.27) in men and from 1.47 (95% CI = 1.38 to 1.56) to 1.81 (95% CI = 1.72 to 1.90) in women; the RR for female breast cancer increased from 1.14 (95% CI = 1.09 to 1.18) to 1.29 (95% CI = 1.25 to 1.34); the RR for prostate cancer increased from 1.45 (95% CI = 1.35 to 1.55) to 1.76 (95% CI = 1.66 to 1.86). Absolute disparities, as measured by RDs, increased for female breast cancer, decreased for lung cancer in men, and remained unchanged for other sex and disease groups. Generally similar patterns were observed between racial and ethnic groups (Supplementary Table 1, available online) and across census regions (Supplementary Table 2, available online).

We found that progress in reducing death rates for the four major cancer sites in the United States continues to be slower in less–educated persons than more–educated persons, leading to widening relative educational disparities in cancer mortality. These differential trends largely reflect educational differences in historical patterns of prevalence of major risk factors (smoking for lung cancer and colorectal cancer, and obesity for colorectal cancer and postmenopausal breast cancer), uptake of cancer screening for breast and colorectal cancers, and receipt of timely and high-quality treatment for all four cancers, driven by social determinants of health, such as poverty, health literacy, and the built environment (7).

Progress in reducing smoking prevalence over the past decades has been slower in persons with lower SES than higher SES

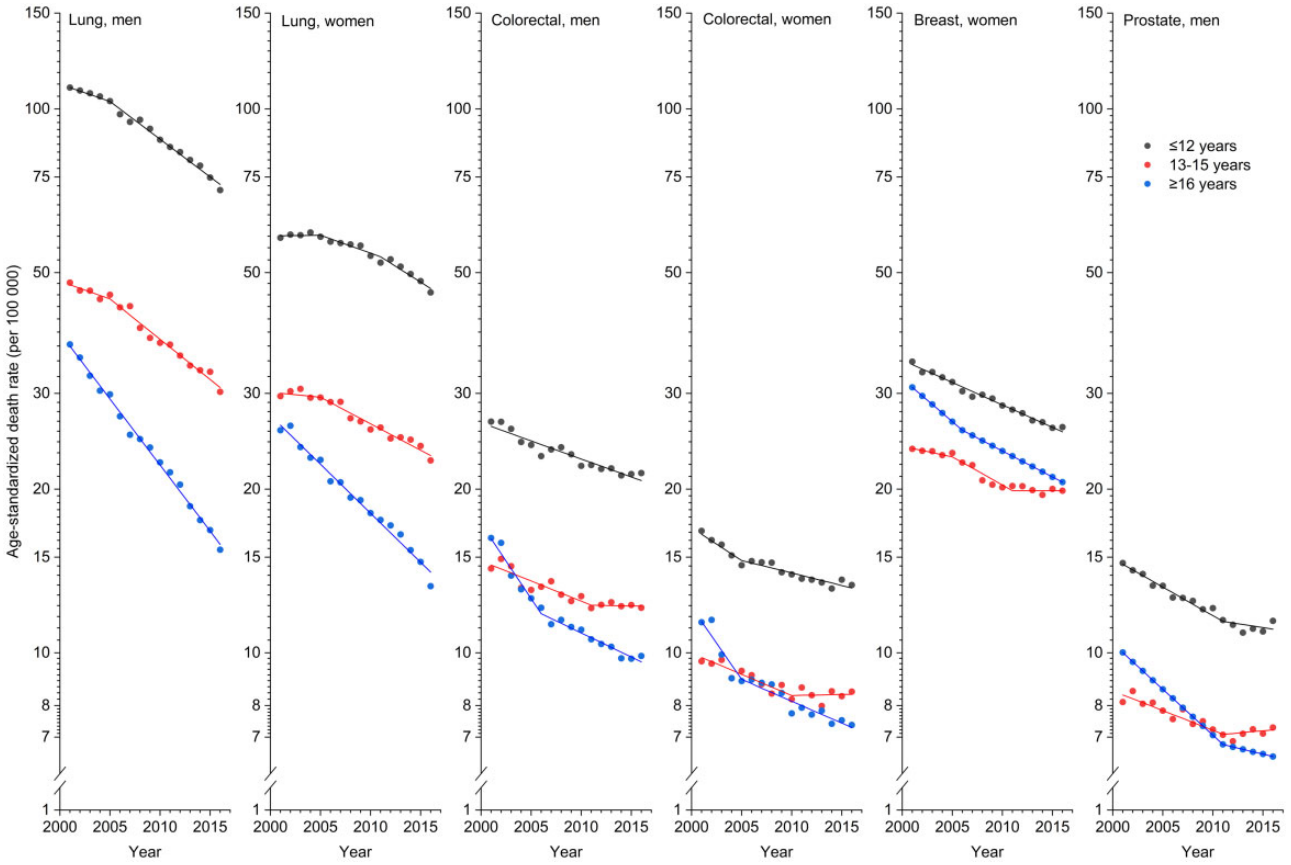

Figure 1. Trends in death rates from major cancer sites by education and sex, 2001–2016.

largely because persons with lower SES have limited access to smoking cessation counseling and treatment, and they are more likely to be targeted by tobacco companies for cigarette marketing (8–10). For example, during 1974–2016 adult smoking prevalence decreased from 43.7% to 26.0% among those with fewer than 12 years of education compared with from 27.2% to 6.5% among those with at least 16 years of education (8). Although obesity prevalence increased in every segment of the US population since the 1970s, the prevalence has been considerably higher in less–educated than in highly educated persons (11). Moreover, partly because of a lack of health insurance, persons with a lower SES are less likely to be up to date with screening, more likely to be diagnosed with distant-stage disease, and less likely to receive timely, standard treatments. For example, during 2000–2015, the colorectal cancer screening rate increased from 26.7% to 46.4% among those with less than a high school education compared with an increase from 44.2% to 67.9% among those with more than a high school education (12).

It is noteworthy that educational disparities in lung cancer mortality widened on a relative scale but narrowed on an absolute scale in men. The occurrence of discordant trends in disparities was attributed to high baseline death rates among those with 12 or fewer years of education who experienced a larger but slower decrease in lung cancer death rates than those with at least 16 years of education. It reflects some progress in reducing disparity and disease burden in low SES populations, but the reduction was not large enough to also reduce relative disparity.

Two limitations of this study need to be noted. First, our study included only persons ages 25–74 years because some may not attain their highest education before age 25 years, and education information on the death certificate for the elderly tends to be inaccurate (13). Second, our findings may not reflect the full spectrum of the socioeconomic disparities in cancer mortality given that SES is a multidimensional construct composed of income, employment, and wealth, among other factors. Nevertheless, our study extends previous research on socioeconomic differences in cancer mortality by examining the most recent trends using individual-level education as a marker of SES. The widening relative disparities in death rates from major cancers reemphasize the need for targeted programs to enhance the dissemination of known interventions in persons with lower SES.

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