

## Death Rates Among Female Smokers Converging With Those for Men

Thun MJ, Carter BD, Feskanish D, et al. 50-Year trends in smoking-related mortality in the United States. *N Engl J Med* 2013;368:251–64.

### Study Overview

**Objective.** To examine trends in smoking-related disease risk in the past 50 years, and to compare risks between men and women.

**Design.** Prospective cohort study to examine mortality trends across 3 time periods: 1959–1965, 1982–1988, and 2000–2010.

**Setting and participants.** Three study populations were used for this study. The CPS I data analysis included 183,060 men and 335,922 women who were enrolled in 1959 and followed through 1965. The CPS II data analysis included 293,592 men and 452,893 women who were enrolled in 1982 and followed through 1988. For the time period of 2000–2010, there were 5 contemporary cohort studies including the National Institutes of Health – American Association of Retired Persons Diet and Health Study (NIH-AARP), the ACS CPS II Nutritional Cohort, the Women’s Health Initiative, the Nurses’ Health Study, and the Health Professionals Follow-up Study.

**Main outcome measures.** The analysis compared age-adjusted mortality estimates for current smokers and former smokers compared with never smokers. Cox proportional-hazards regression models were used to calculate age-adjusted relative risk estimates for men and women by smoking status, intensity of smoking, and duration of smoking. These analyses were controlled for race and education levels. As sensitivity analysis, the authors assessed whether mortality trends varied by education level.

**Main results.** The cohorts were notable for being predominantly white and non-Hispanic. Education level varied by time period, with almost 50% of the contemporary cohort (2000–2010) having a college or nursing school education. The prevalence of smoking declined significantly over the 50-year time period; however, there were significant differences by gender. The prevalence of smoking for women was lower than that for men in the 1959–1965 (15.2% versus 39.5%) and 1982–1988 (18.0% versus 23.5%) time periods, but was equal to that

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of men in the 2000–2010 time period (9.7% versus 9.3%). Compared to the earlier cohorts where individuals smoked  $\geq 20$  cigarettes per day, more than half of the contemporary cohort smoked  $< 20$  cigarettes per day. Women smoked as much as men in the contemporary cohort. Age of smoking initiation for men remained stable over time, but increased for women who had initiated smoking when they were less than 30 years of age. Compared with never smokers, the relative risk of death from all causes increased significantly for current smokers over the 50 years. While in the earlier cohorts the risk of death from all causes was greater for men compared with women, in the later cohorts the risk of death was equal for men and women. In the 2000–2010 cohort, the relative risk of all-cause mortality was 2.76 (95% CI 2.69–2.84) for women and 2.80 (95% CI 2.72–2.88) for men who were current smokers. There were significant increases in deaths from lung cancer, COPD, and cardiovascular disease among women over the 50-year time period. Relative to women nonsmokers, smokers had an age-adjusted relative risk of 25.66 (95% CI 23.17–28.40) for lung cancer, 22.35 (95% CI 19.55–25.55) for COPD, and 2.86 (95% CI 2.65–3.08) for ischemic heart disease in the 2000–2010 time period. The relative risk estimates for women were similar to those among men in the contemporary time period. Among men, the risk of death from smoking-related conditions plateaued at the high levels observed in the 1980s, except for COPD where the risk continued to increase. The relative risks of death from lung cancer, COPD, and all causes were greater for smokers (compared to non-smokers) who smoked more cigarettes per day and for longer periods of time across the 3 time periods. Former smokers who quit smoking before the age of 40 years were able to reverse nearly all of the smoking-related deaths from lung cancer, COPD, and cardiovascular conditions. In sensitivity analysis, education significantly modified the association of smoking and mortality. The estimated relative risks for current or former smokers with only a high-school education or less were generally the same or greater than those with a college education for most of the outcomes.

**Conclusion.** Smoking-related deaths have increased among women over the past 50 years, and are now equal to that among men. Among men, the risks of smoking-related deaths have plateaued at the high levels

as observed in the 1980s, but deaths from COPD have continued to increase.

### Commentary

Smoking continues to be the leading cause of preventable deaths in the United States. Approximately 443,000 men and women die from tobacco use yearly in this country. Smoking is responsible for \$193 billion dollars in lost productivity and health care expenditures and significant declines in health-related quality of life [1]. The current study offered a 50-year prospective view on smoking-related mortality in the United States, and highlighted new demographic differences in mortality during this time period.

The most important finding from this study is that the risk of death from smoking has increased among women and is nearly identical to that among men. These results are in contrast to previous studies from earlier decades that showed lower risks among women compared with men [2]. Women who were smokers in the contemporary cohort (2000–2010) had a 25-fold increased risk of death from lung cancer and COPD compared with nonsmokers. These relative risks were identical to that among men. While aging of birth cohorts with the highest cumulative history of smoking could explain part of these trends, the convergence of smoking behaviors between men and women (ie, women smoke as much and for the same length of time as men do) is also a likely explanation. The study showed an increase in smoking-related mortality among men aged 55 to 74 years and among women aged 60 to 74 years. These results suggest that most of the deaths experienced among current smokers in this age-group are associated with smoking. Interestingly, while rates of lung cancer stabilized for men in the later cohorts, rates continued to increase for women. These results highlight the importance of lung cancer as a significant cause of death among women.

The risk of death from COPD continued to increase for both men and women in the contemporary cohorts. This increase occurred at the same time when there were significant changes in smoking behaviors. Intensity of smoking declined in the mid 1990s, with most smokers smoking fewer cigarettes per day [3], but average duration of smoking did not change. The type of cigarettes smoked also changed in the contemporary time periods, with most smokers smoking filtered cigarettes with less tar compared to the early time periods when

they were smoking unfiltered cigarettes. The authors suggested that design changes in cigarettes that allowed for deeper inhalation might have increased risk for COPD.

Another important finding from this study is that the risk of death from smoking is almost entirely reversed if individuals quit smoking before the age of 40 years. As people are smoking fewer cigarettes per day, the findings suggest that light to moderate smoking can still pose significant long-term risks and that smoking cessation is much more effective in reducing these risks than smoking reduction. Although the sensitivity analyses revealed no major differences in the risk of death by education level, it is possible that the risk could be higher for individuals with low educational attainment. Thus, one of the limitations of this study is that the cohorts lacked adequate representation from individuals who had low educational attainment. Similarly, individuals of low socioeconomic status and those who belonged to racial/ethnic minorities were underrepresented in these cohorts. This is indicated by the fact that smoking rates in this study were significantly lower than those observed in the general population (9.5% versus 19%); individuals who smoke at high rates may be underrepresented in these cohorts. By not including high-risk populations, findings may similarly underestimate the overall mortality among smokers. The strengths of this study are its size, its prospective study design, and its ability to provide a 50-year view on smoking-related disease risks among men and women in the United States.

### **Applications for Clinical Practice**

There are several important implications from this study. Clinicians should encourage all smokers to quit smoking; these counseling messages should be directed toward helping people make quit attempts. In addition to counseling on smoking cessation, clinicians should educate smokers on the harms of smoking and the risk that their smoking poses to others from secondhand smoke exposure. In combination with smoking cessation counseling, clinicians should encourage individuals to implement home smoking restrictions, which have been shown to reduce exposure to secondhand smoke and encourage quit attempts and successful cessation. Public health and educational campaigns need to emphasize the very high rates of death from lung cancer and COPD among women. These health care, public health, and educational interventions should be targeted toward low-income populations where smoking is concentrated.

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