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# Educational inequalities in smoking: The role of initiation versus quitting

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ABSTRACT

The existing literature on educational inequalities in adult smoking has focused extensively on differences in current smoking and quitting, rather than on differences in never smoking regularly (initiation) by education in the adult population. Knowing the relative contribution of initiation versus quitting is critical for understanding the mechanisms that produce educational gradients in smoking because initiation and quitting occur at different points in the life course. Using data from 31 waves of the U.S. National Health Interview Survey ($N$ = 587,174), the analyses show the relative likelihood of being a never versus former smoker by education, sex, and age from 1966 to 2010 and for birth cohorts from 1920 to 1979. The analyses also describe differences in the cumulative probability of quitting over the life course, and the role of initiation versus quitting in producing educational gaps in smoking. The results show that educational gaps in never smoking explain the bulk of the educational inequality in adult smoking. Differences in former smoking play a small and decreasing role in producing these gaps. This is true across the life course, whether measured at age 25 or age 50, and for both men and women. While the prevalence and age patterns of former smoking by education converge across birth cohorts, differences in never smoking by education increase dramatically. At the population level, educational gaps in adult smoking are produced by the combination of inequalities in initiation and quitting, with differences in initiation playing a larger role in producing the observed gaps. The portion of the gap explained by differences in quitting is itself a function of educational differences in initiation. Thus, educational gradients in adult smoking are tethered to experiences in adolescence. These findings have important implications for both understanding and addressing disparities in this important health behavior.

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## Introduction

Smoking is the leading behavioral cause of death in the United States, with smoking-related illnesses accounting for nearly 20% of all deaths each year (Centers for Disease Control and Prevention (CDC), 2008). Given this toll, educational disparities in smoking represent one of the deadliest examples of social inequalities in health. In 2009, about a quarter of those with high school or less completed were current smokers compared to 20% of those with an associate degree, 11% of those with an undergraduate degree, and 5.6% of those with a graduate degree (CDC, 2010). Data from retrospective smoking histories, however, suggest that this pattern of smoking by education has changed dramatically over time (de Walque, 2010). The retrospective data suggest that, before the 1950s, smoking rates were relatively high among all education groups. Then, as information about the negative health effects of smoking diffused in the research literature and media, smoking rates declined for all education groups, but dropped especially rapidly for college graduates. Over the next 30 years, declines in smoking among college graduates outpaced those of other education groups, and a large educational gradient in smoking emerged (Gilpin & Pierce, 2002; Pampel, 2005, 2009; Pierce, Fiore, Novotny, Hatziandreu, & Davis, 1989; de Walque, 2010).

A large and multidisciplinary literature has examined trends in these educational inequalities in smoking. The existing literature has focused nearly entirely on differences in current smoking and quitting by education (Escobedo & Peddicord, 1996; Fiore et al., 1989; Garfinkle, 1997; Gilpin & Pierce, 2002; Pampel, 2005, 2009; Pierce et al., 1989; Reid, Hammond, Boudreau, Fong, & Siahpush, 2010; Sander, 1995a, 1995b; Smith & Fiore, 1999; de Walque, 2007, 2010). Very few studies, however, have examined the role of never smoking (initiation) in explaining educational gradients in adult smoking (Fiore et al., 1989; Pierce et al., 1989). This is an important gap in the literature because differences in smoking

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prevalence are a function of both differences in quitting and differences in smoking initiation (Fiore et al., 1989).

The causal pathways between education and smoking are both complicated and contested in the literature. Numerous confounding factors might produce the observed association between education and smoking. These factors might include differences in time preferences, aspirations, friends and social networks, risk preferences, and cognitive and noncognitive skills (Cutler & Lleras-Muney, 2010; Farrell & Fuchs, 1982; McDade et al., 2011; Tenn, Herman, & Wendling, 2010; U.S. Department of Health and Human Services, 2012; de Walque, 2010). The relationship between schooling and never smoking is even more difficult to disentangle. Never smoking regularly is a function of smoking initiation, which is a status that is determined early in life, most often in adolescence. Individuals who have never smoked regularly by age 20 have a very low likelihood of smoking at a later age (Chassin, Presson, Rose, & Sherman, 1996; Chen & Kandel, 1995; Lanz, 2003). This means that never smoking regularly is a status that is predominantly determined before education is completed. In contrast, current smoking and quitting are behaviors that occur across the life course (Gilpin & Pierce, 2002).

Whatever the underlying relationships, never smoking regularly plays an important but understudied role in the relationship between education and adult smoking. First, as the prevalence of current smoking decreases, the prevalence of never and former smoking increases. Thus, educational inequalities in current smoking are linked to inequalities in never and former smoking. An important but currently unanswered question is: how much of the educational gap in current smoking is explained by differences in never smoking (initiation) versus former smoking (quitting)? Second, differences in quitting can only explain educational gradients in smoking when the share of ever smokers is large for all education groups. But as the fraction of never smokers among the highly educated grows, the fraction of those who have ever smoked shrinks. As a result, differential quit ratios, no matter how large, apply to a shrinking part of the population, at least for the highly educated. The analyses below demonstrate this point both mathematically and empirically.

The current study examines the contribution of educational differences in never smoking regularly to educational gradients in adult smoking. The analyses examine differences in never smoking and quitting across the life course and trends in these patterns over time and by birth cohort. The analyses also describe the relative role of initiation versus quitting in explaining educational inequalities in smoking. The study shows that educational gradients in current smoking and quitting are tethered to educational inequalities in never smoking regularly (initiation). This has important implications both for understanding the potential mechanisms linking education and smoking and where in the life course inequalities in this important health behavior emerge.

## Data & methods

### *Data*

The analyses use data from 31 waves of the U.S. National Health Interview Surveys (NHIS) from 1966 to 2010 (CDC, 2012). Samples from each individual year are cross-sectional, large, and representative of the non-institutionalized civilian population of U.S. residents. The NHIS samples households. From each household, the NHIS collects a limited set of information on all household members and conducts detailed interviews with one randomly selected adult and child member. NHIS interviews are conducted in person, and the survey has an annual response rate of nearly 90% of eligible households sampled. Ethics approval was not required because these data are de-identified and in the public domain, and the author has no access to any private or identifying information on the respondents.

The survey waves containing both education and smoking information are numerous but not contiguous (1966, 1970, 1974, 1976–1980, 1983, 1985, 1987, 1988, 1990–1992, 1994, 1995, 1997–2010). These 31 data waves provide an overall sample of 587,394 individuals age 25–59. The smallest year-specific sample is from 1980 ($N = 6156$) and the largest is from 1966 ($N = 54{,}465$). Twenty of the 31 waves also contain data on when individuals started and quit smoking (1978–1980, 1987, 1988, 1995, 1997–2010). Using these smoking histories, one can determine the age-specific smoking status of individuals for a set of birth cohorts from the 1920s through the 1970s.

In the analyses that follow, education is categorized in levels, using either a four level grouping (0–11, 12, 13–15, and 16+ years completed) or as a college degree versus less than college completed dichotomy. The college degree dichotomy describes the predominant pattern of educational inequalities in smoking in the U.S. (Pampel, 2009; Pierce et al., 1989; de Walque, 2010). This dichotomy also helps with two other limitations of the more detailed categories. First, in recent decades, the lowest education category (0–11 years) has increasingly become a heterogeneous mix of immigrants and native-born adults with quite different smoking patterns (Pampel, 2009). Second, the education distribution in the U.S. has increased dramatically in the past 50 years, which means that the lowest education group has become increasingly negatively selected over time. The college degree dichotomy helps address both these compositional concerns.

The most consistent way to measure smoking across the survey waves is to use a question asking if the respondent has smoked at least 100 cigarettes. This question is available in nearly all waves. When it was not asked, the survey instead asked respondents to categorize themselves as present, former, or never smokers. For consistency, the analyses use the 100 cigarette question whenever possible and the answer to this latter question when the former was not asked. In the analyses below, smokers are defined as those who report having smoked at least 100 cigarettes in their lifetime and respond "yes" to smoking at the time of the survey. Former smokers are those who have smoked at least 100 cigarettes but respond "no" to smoking currently. Never smokers are defined as those who have not smoked 100 cigarettes or more and are not smoking at the time of the survey. The analyses do not control for the frequency of smoking among current and former smokers because this information is not consistently available in all data waves. Using the data on current and former smokers, I compute the probability of quitting as the ratio of former smokers to ever smokers for a given group, cohort, or period.

All analyses use the NHIS year-specific probability weights to adjust for the sampling design and produce results that generalize to the U.S. population. Overall, the data are quite complete. Education and smoking status are missing for 1% and 1.7% of the sample, respectively. In the waves containing smoking histories, age of smoking initiation is missing for 3.7% of ever smokers. Age of smoking cessation is missing for 3.1% of former smokers. Respondents with missing values on key variables are deleted from the analysis.

Samples are restricted to individuals age 25–59 to capture completed schooling at the younger cutoff and reduce biases produced by differential mortality by education and smoking status at older ages. Analyses are estimated separately for men and women because smoking prevalence differs considerably by sex, both in levels and patterns over time (Fiore et al., 1989). All analyses are also disaggregated by age because smoking behavior changes over the life course and these life course patterns may show inequalities by education as well. Smoking patterns bear a strong birth cohort imprint (Harris, 1983; de Walque, 2010). A cohort pattern is

consistent with the fact that initiation is narrowly bounded in late adolescence. But quitting occurs throughout the life course and is not narrowly bounded by age. Thus, it is important to examine educational trends in smoking both across historical time and by birth cohort.

### *Analysis*

The analyses aim to answer two questions. First, how much of the observed educational inequalities in current smoking are due to educational differences in never smoking? Second, what is the relative contribution of never smoking (initiation) versus quitting in explaining educational gradients in adult smoking? In order to answer these questions, the analyses first show trends in the prevalence of never smoking by education both by period and birth cohort. In order to see if inequalities in current smoking are produced by the highly educated quitting more, the analyses examine the relative share of never and former smokers by education at ages 25, 30, 40, and 50 by birth cohort. I also show trends in the cumulative probability of quitting over the life course by age, education, and cohort. Finally, putting these parts together, I describe both analytically and empirically the relative role of initiation versus quitting in producing educational gradients in adult smoking.

## Results

### *Trends over time*

Fig. 1 shows trends by year in the prevalence of current, former, and never smoking by education, age, and sex. The first two rows show trends for men age 25–34 and age 35–59, respectively. The third and fourth rows show these same trends for women. For men age 25–34, although the prevalence of smoking has declined for all education groups, there is a distinct gradient by education, and a large gap in prevalence between college graduates and those with less schooling. This pattern has persisted from 1966 to 2010. Comparing trends for former versus never smokers, the graphs show that the education gap in current smoking is explained almost entirely by educational differences in never smoking. The small gap in the prevalence of former smokers by education that existed in 1966 disappeared by 1990, while the gap in the prevalence of never smokers between college graduates and the other education groups persisted across the five decades. In 2010, about 12% of male college graduates were current smokers compared to about 35% of the other education groups. At the same time, three-fourths were never smokers compared to about half of those with less schooling.

This pattern holds for older men as well. While overall levels of former smoking are higher for men age 35–59, the educational gradient in the share of former smokers is small and closing over time. Instead, the proportion of never smokers shows large differences by education, even for this older age group. This pattern is also true for women, although educational gradients in smoking emerged more recently for women than for men. Nonetheless, for women too, the gap in current smoking by education reflects differences in never smoking for both younger and older women rather than a growing share of former smokers among the highly educated. In 2010, female college graduates age 25–34 had nearly a 20 percentage point lower prevalence of current smoking (9% versus about 30% for the other education groups) and a comparable advantage in their prevalence of never smoking (79% versus about 58%).

Table 1 examines these patterns in more detail. The table shows educational gaps in the prevalence of never and former smokers by age, sex, and year. Except for 1966, the survey years are grouped to reduce sampling variability. The year ranges are 1966, 1970–1975, then 5-year intervals from 1976 to 2010. The education contrast is the gap (in percentage points) between college graduates and individuals with less than college completed. The sum of the gaps in never and former smoking is the total educational gap in nonsmoking in that period. The gap in current smoking in that period (not shown) is also the sum of the gaps in never and former smoking, but with the opposite sign.

For men age 25–34 in 1966, college graduates had an 18 percentage point advantage in the prevalence of never smoking. They also had a 7 percentage point advantage in the prevalence of former smoking. In 1966, the educational gap in never smoking accounted for about 72% of the overall gap in nonsmoking between college graduates and those with less schooling. By 1980, however, differences in never smoking account for the entire educational gap in nonsmoking. This pattern is similar for older men as well. For men age 35–44, differences in never smoking by education account for about two-thirds of the gap in nonsmoking until the 1980s, and for the entire educational gap in nonsmoking from 1990 onward. For men age 45–59, educational differences in never smoking account for an increasing share of the education gap in nonsmoking from 1966 to 1995, and the entire gap in nonsmoking from 1996 onward.

The patterns for women initially lagged those observed for men, but differences by sex have converged over time. For women age 25–34, educational gaps in never and former smoking were initially about equal. Then, starting in the late 1970s, the gap in never smoking grew steadily until the mid 1980s, after which it accounted for the entire educational gap in nonsmoking. For women age 35–44, differences in former smoking explained most of the educational differences in nonsmoking from the mid 1960s until 1980. From 1980 to the mid 1990s, however, the educational gap in never smoking grew steadily while the educational gap in former smoking declined. By the mid 1990s, educational differences in never smoking accounted for the entire gap in nonsmoking. Cohort aging carried these patterns forward for women ages 45–59. For this oldest group, educational differences in former smoking account for the entire gap in nonsmoking until 1990. From the 1990s onward, educational differences in never smoking increase steadily and, by 2006–2010, account for the entire gap in nonsmoking.

### *Trends by birth cohort*

#### *Never and former smoking*

Table 2 (men) and Table 3 (women) show smoking status across the life course for six consecutive birth cohorts. For each birth cohort, the tables show the proportion of the cohort who were current, former, or never smokers at age 25, 30, 40, and 50 for college graduates versus individuals with less than college completed. The last three columns show the educational gaps in never and former smoking and the ratio of the gap in never smoking to the overall educational gap in nonsmoking.

When men in the 1920–1929 birth cohort were age 25, 35% of college graduates were never smokers compared to 24% of men with less schooling. The education groups had the same share of former smokers at age 25, thus, at this early age, differences in initiation accounted for all the education difference observed in smoking status. For this birth cohort, differences in quitting emerge by age 40, and by age 50, educational differences in smoking were nearly evenly divided between differences in never and former smokers (gaps of 9 and 7 percentage points, respectively). For men in the 1930–1939 birth cohort, differences in never smoking at age 50 account for about two-thirds of the educational gap in nonsmoking. For all subsequent birth cohorts, educational differences in never smoking across the life course account for nearly the entire gap in nonsmoking.

Across the life course, the prevalence of former smokers by education converges across birth cohorts. In the 1920–1929 and

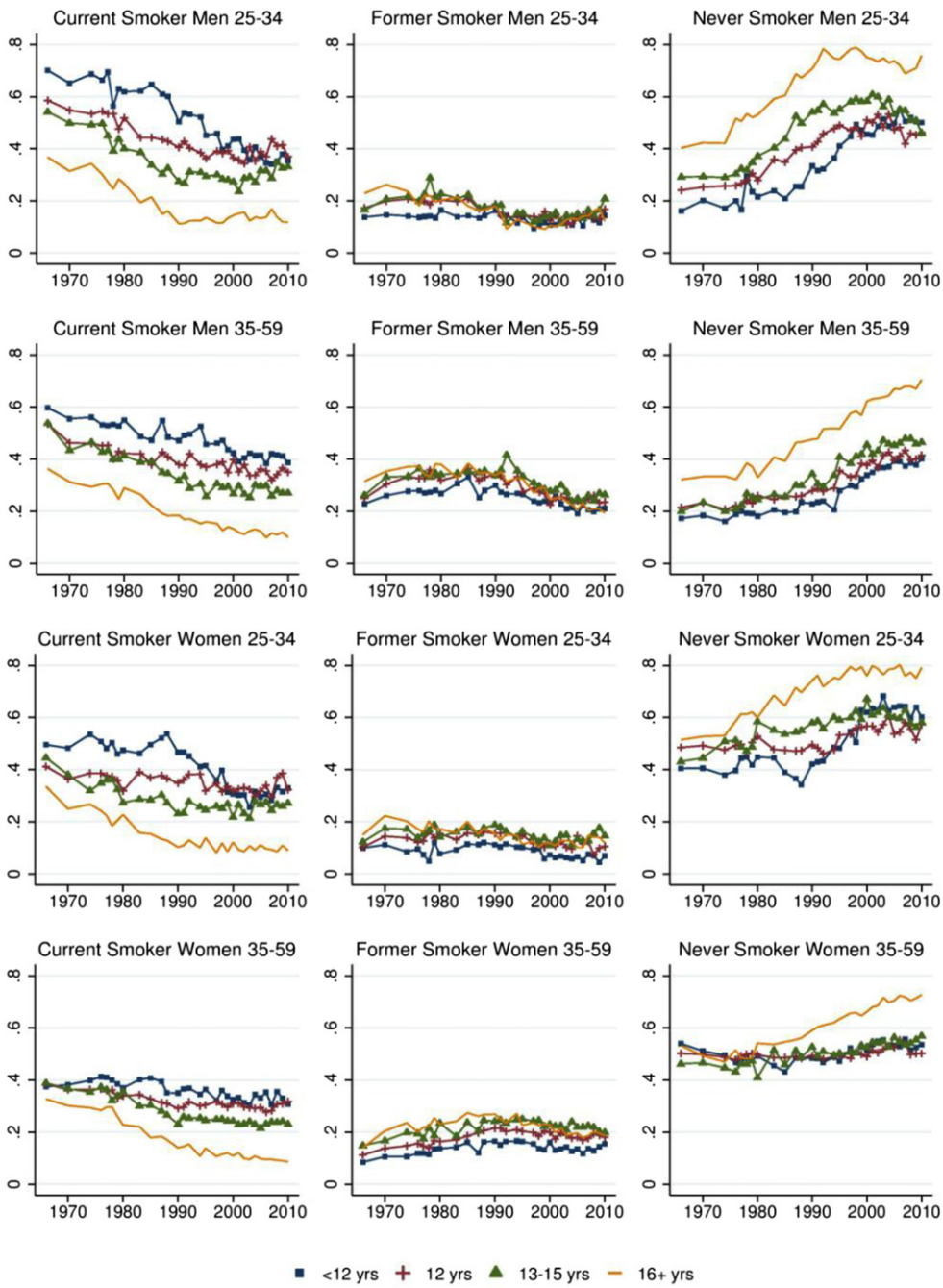


**Fig. 1.** Smoking status (% prevalence) by education, sex, and age from 1966 to 2010, NHIS.

1930–1939 cohorts, the educational gap in the proportion of men who were former smokers increased with age. By the 1940–1949 birth cohort, however, these life course patterns in the proportion of former smokers at each age converge across education groups. For men, from the 1940 cohort onward, differences in quitting by education do not produce a widening gap in former smoking by education across the life course.

Educational differences in never smoking emerge for women in the 1930–1939 cohort (Table 3). For women born in 1930–1939 and 1940–1949, educational differences in nonsmoking are explained by differences in never smoking at younger ages and nearly equally divided between differences in former and never smoking at older ages. By the 1950–1959 cohort, this pattern disappears and, like men, educational differences in smoking are nearly entirely explained by differences in never smoking across the life course. For women, educational differences in former smoking increase by age up to the 1940–1949 birth cohort, but then converge. In contrast, the proportion of female college graduates who are never smokers increases steadily across cohorts.

*Quitting probabilities*

The analyses above show that educational differences in the prevalence of former smoking have converged across birth cohorts. This does not mean, however, that differences in the probability of quitting have converged. Table 4 shows life course patterns in the

**Table 1**
Educational gaps (percentage points shown) in never and former smoking by sex, age, and period, NHIS.

| | Year | Sample size | | Men | | | Women | | |
|---|---|---|---|---|---|---|---|---|---|
| | | <16 yrs | 16+ yrs | Gap never | Gap former | Never/total | Gap never | Gap former | Never/total |
| Age 25–34 | 1966 | 13,135 | 2017 | 0.18* | 0.07* | 0.72 | 0.06* | 0.05* | 0.58 |
| | 1970–1975 | 15,758 | 3194 | 0.18* | 0.05* | 0.79 | 0.07* | 0.07* | 0.50 |
| | 1976–1980 | 15,092 | 4550 | 0.24* | 0.00 | 0.98 | 0.12* | 0.04* | 0.74 |
| | 1981–1985 | 10,043 | 3232 | 0.25* | 0.00 | 1.00 | 0.18* | 0.03* | 0.84 |
| | 1986–1990 | 19,086 | 6128 | 0.27* | 0.00 | 1.00 | 0.23* | 0.01 | 0.97 |
| | 1991–1995 | 15,305 | 5254 | 0.28* | −0.02* | 1.09 | 0.23* | −0.01 | 1.05 |
| | 1996–2000 | 19,119 | 6888 | 0.26* | −0.03* | 1.14 | 0.19* | 0.00 | 0.99 |
| | 2001–2005 | 20,614 | 8369 | 0.21* | −0.01 | 1.06 | 0.18* | 0.00 | 0.98 |
| | 2006–2010 | 15,261 | 6969 | 0.22* | 0.00 | 1.01 | 0.19* | 0.01 | 0.94 |
| Age 35–44 | 1966 | 15,440 | 1869 | 0.14* | 0.07* | 0.66 | 0.02 | 0.06* | 0.26 |
| | 1970–1975 | 14,448 | 2273 | 0.18* | 0.09* | 0.66 | 0.03 | 0.10* | 0.20 |
| | 1976–1980 | 11,532 | 2591 | 0.14* | 0.06* | 0.70 | 0.05* | 0.08* | 0.40 |
| | 1981–1985 | 7298 | 2466 | 0.19* | 0.02 | 0.89 | 0.11* | 0.08* | 0.57 |
| | 1986–1990 | 15,189 | 5976 | 0.23* | 0.03* | 0.89 | 0.11* | 0.06* | 0.65 |
| | 1991–1995 | 13,927 | 5446 | 0.23* | 0.00 | 1.02 | 0.16* | 0.03* | 0.83 |
| | 1996–2000 | 20,956 | 7187 | 0.26* | −0.01 | 1.05 | 0.20* | 0.00 | 1.00 |
| | 2001–2005 | 23,040 | 8715 | 0.26* | −0.03* | 1.11 | 0.21* | −0.01 | 1.05 |
| | 2006–2010 | 15,375 | 6946 | 0.26* | −0.02* | 1.10 | 0.19* | 0.01 | 0.97 |
| Age 45–59 | 1966 | 20,130 | 1874 | 0.13* | 0.09* | 0.58 | 0.01 | 0.02 | 0.36 |
| | 1970–1975 | 22,043 | 2396 | 0.11* | 0.06* | 0.67 | −0.04 | 0.09* | −0.88 |
| | 1976–1980 | 17,753 | 2664 | 0.12* | 0.06* | 0.68 | 0.00 | 0.07* | 0.01 |
| | 1981–1985 | 8868 | 1767 | 0.12* | 0.03 | 0.78 | 0.01 | 0.08* | 0.13 |
| | 1986–1990 | 15,180 | 3849 | 0.15* | 0.03* | 0.82 | 0.02 | 0.09* | 0.17 |
| | 1991–1995 | 13,829 | 4337 | 0.17* | 0.03* | 0.85 | 0.09* | 0.05* | 0.64 |
| | 1996–2000 | 22,190 | 7888 | 0.19* | 0.01 | 0.96 | 0.09* | 0.06* | 0.62 |
| | 2001–2005 | 28,686 | 10,805 | 0.21* | −0.01 | 1.06 | 0.12* | 0.03* | 0.82 |
| | 2006–2010 | 23,142 | 9085 | 0.24* | −0.03* | 1.15 | 0.17* | 0.00 | 0.97 |

Notes: *indicates gap is significantly different from zero at $p < 0.05$. Gap denotes % prevalence of college graduates minus <16 years group. Total is the sum of the gaps in never and former smoking.

cumulative probability of quitting by education, sex, and birth cohort. The table shows the age-specific cumulative quitting probabilities for each education group in each birth cohort, as well as the absolute and relative differences in quitting at each age (Harper & Lynch, 2006).

Educational differences in quitting widen over the life course for both men and women for all cohorts. Age patterns of quitting, however, differ by education across cohorts. For male college graduates, the cumulative quitting probability at age 30 increased from 0.08 to 0.42 from the oldest to the youngest birth cohort. In

**Table 2**
Distribution of smoking status (%) across life course by birth cohort, men, NHIS.

| Cohort | <16 yrs education | | | 16+ yrs education | | | Gap never | Gap former | Never/total |
|---|---|---|---|---|---|---|---|---|---|
| | Current | Never | Former | Current | Never | Former | | | |
| 1920–29 | | | | | | | | | |
| Age 25 | 0.74 | 0.24 | 0.02 | 0.62 | 0.35 | 0.02 | 0.12* | 0.00 | 1.01 |
| Age 30 | 0.73 | 0.23 | 0.05 | 0.62 | 0.32 | 0.06 | 0.10* | 0.01 | 0.90 |
| Age 40 | 0.64 | 0.22 | 0.14 | 0.51 | 0.31 | 0.18 | 0.09* | 0.04* | 0.70 |
| Age 50 | 0.51 | 0.22 | 0.27 | 0.35 | 0.31 | 0.34 | 0.09* | 0.07* | 0.57 |
| 1930–39 | | | | | | | | | |
| Age 25 | 0.69 | 0.27 | 0.03 | 0.50 | 0.45 | 0.05 | 0.17* | 0.02* | 0.91 |
| Age 30 | 0.66 | 0.26 | 0.08 | 0.46 | 0.42 | 0.12 | 0.16* | 0.03* | 0.83 |
| Age 40 | 0.55 | 0.25 | 0.20 | 0.35 | 0.41 | 0.24 | 0.16* | 0.04* | 0.79 |
| Age 50 | 0.44 | 0.25 | 0.30 | 0.22 | 0.40 | 0.38 | 0.15* | 0.08* | 0.64 |
| 1940–49 | | | | | | | | | |
| Age 25 | 0.63 | 0.31 | 0.05 | 0.43 | 0.50 | 0.07 | 0.18* | 0.02* | 0.92 |
| Age 30 | 0.59 | 0.30 | 0.11 | 0.38 | 0.49 | 0.13 | 0.19* | 0.03* | 0.87 |
| Age 40 | 0.49 | 0.31 | 0.20 | 0.27 | 0.49 | 0.25 | 0.18* | 0.04* | 0.81 |
| Age 50 | 0.37 | 0.31 | 0.31 | 0.18 | 0.49 | 0.33 | 0.17* | 0.02 | 0.91 |
| 1950–59 | | | | | | | | | |
| Age 25 | 0.53 | 0.41 | 0.06 | 0.28 | 0.65 | 0.07 | 0.24* | 0.01* | 0.96 |
| Age 30 | 0.50 | 0.40 | 0.10 | 0.24 | 0.64 | 0.12 | 0.24* | 0.02* | 0.92 |
| Age 40 | 0.43 | 0.39 | 0.18 | 0.18 | 0.63 | 0.19 | 0.24* | 0.01 | 0.97 |
| Age 50 | 0.36 | 0.38 | 0.26 | 0.15 | 0.61 | 0.24 | 0.23* | −0.02* | 1.10 |
| 1960–69 | | | | | | | | | |
| Age 25 | 0.44 | 0.52 | 0.05 | 0.17 | 0.78 | 0.05 | 0.27* | 0.00 | 1.01 |
| Age 30 | 0.41 | 0.50 | 0.08 | 0.16 | 0.77 | 0.07 | 0.26* | −0.01* | 1.03 |
| Age 40 | 0.38 | 0.48 | 0.15 | 0.13 | 0.73 | 0.13 | 0.26* | −0.01 | 1.06 |
| 1970–79 | | | | | | | | | |
| Age 25 | 0.39 | 0.55 | 0.07 | 0.18 | 0.77 | 0.05 | 0.22* | −0.01* | 1.06 |
| Age 30 | 0.37 | 0.53 | 0.10 | 0.14 | 0.76 | 0.10 | 0.23* | −0.01 | 1.02 |

Notes: *$p < 0.05$; gap denotes % prevalence of college graduates minus <16 years group. Total is the sum of the gaps in never and former smoking.

**Table 3**
Distribution of smoking status (%) across life course by birth cohort, women, NHIS.

| Cohort | <16 yrs education | | | 16 + yrs education | | | Gap never | Gap former | Never/total |
|---|---|---|---|---|---|---|---|---|---|
| | Current | Never | Former | Current | Never | Former | | | |
| 1920–29 | | | | | | | | | |
| Age 25 | 0.38 | 0.61 | 0.01 | 0.40 | 0.60 | 0.01 | −0.02 | 0.00 | 1.17 |
| Age 30 | 0.41 | 0.58 | 0.01 | 0.42 | 0.56 | 0.02 | −0.02 | 0.01 | 1.50 |
| Age 40 | 0.40 | 0.55 | 0.04 | 0.38 | 0.53 | 0.09 | −0.02 | 0.04* | −1.10 |
| Age 50 | 0.35 | 0.54 | 0.10 | 0.32 | 0.52 | 0.16 | −0.02 | 0.05* | −0.57 |
| 1930–39 | | | | | | | | | |
| Age 25 | 0.44 | 0.54 | 0.02 | 0.39 | 0.58 | 0.03 | 0.04* | 0.02* | 0.70 |
| Age 30 | 0.45 | 0.51 | 0.04 | 0.37 | 0.56 | 0.07 | 0.05* | 0.03* | 0.59 |
| Age 40 | 0.41 | 0.49 | 0.09 | 0.31 | 0.55 | 0.14 | 0.06* | 0.05* | 0.53 |
| Age 50 | 0.34 | 0.50 | 0.15 | 0.22 | 0.56 | 0.23 | 0.06* | 0.07* | 0.44 |
| 1940–49 | | | | | | | | | |
| Age 25 | 0.42 | 0.55 | 0.03 | 0.33 | 0.61 | 0.06 | 0.07* | 0.02* | 0.75 |
| Age 30 | 0.41 | 0.52 | 0.06 | 0.29 | 0.60 | 0.11 | 0.07* | 0.05* | 0.61 |
| Age 40 | 0.37 | 0.52 | 0.12 | 0.22 | 0.59 | 0.20 | 0.07* | 0.08* | 0.45 |
| Age 50 | 0.29 | 0.52 | 0.18 | 0.15 | 0.59 | 0.26 | 0.07* | 0.08* | 0.47 |
| 1950–59 | | | | | | | | | |
| Age 25 | 0.40 | 0.55 | 0.05 | 0.24 | 0.70 | 0.06 | 0.15* | 0.01* | 0.91 |
| Age 30 | 0.39 | 0.54 | 0.08 | 0.21 | 0.69 | 0.10 | 0.16* | 0.02* | 0.86 |
| Age 40 | 0.33 | 0.53 | 0.14 | 0.15 | 0.68 | 0.17 | 0.15* | 0.03* | 0.83 |
| Age 50 | 0.28 | 0.54 | 0.18 | 0.12 | 0.67 | 0.21 | 0.13* | 0.03* | 0.82 |
| 1960–69 | | | | | | | | | |
| Age 25 | 0.39 | 0.57 | 0.05 | 0.16 | 0.78 | 0.05 | 0.22* | 0.01* | 0.97 |
| Age 30 | 0.37 | 0.55 | 0.08 | 0.14 | 0.77 | 0.09 | 0.22* | 0.01* | 0.95 |
| Age 40 | 0.33 | 0.53 | 0.14 | 0.11 | 0.75 | 0.14 | 0.22* | 0.00 | 0.99 |
| 1970–79 | | | | | | | | | |
| Age 25 | 0.33 | 0.62 | 0.05 | 0.15 | 0.79 | 0.06 | 0.17* | 0.00 | 0.98 |
| Age 30 | 0.30 | 0.62 | 0.08 | 0.12 | 0.78 | 0.10 | 0.16* | 0.02* | 0.89 |

Notes: *$p < 0.05$; gap denotes % prevalence of college graduates minus <16 years group. Total is the sum of the gaps in never and former smoking.

contrast, for men with less than college completed, the probability of quitting at age 30 increased from 0.06 to 0.22 across those same birth cohorts. These patterns are similar for women. In more recent birth cohorts, male and female college graduates also quit at younger ages than individuals with less schooling. Thus, college graduates are both more likely to quit smoking and more likely to quit earlier in life than individuals with less schooling. For men, educational differences in the cumulative probability of quitting at age 50 are fairly stable from the 1930 to 1950 birth cohorts. For women, the educational gap in quitting at age 50 increases until the 1940–1949 birth cohort and then remains stable.

**Table 4**
Quitting probabilities by education, age, sex, and birth cohort, NHIS.

| Age | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | <16 yrs | 16+ yrs | Gap | Ratio | <16 yrs | 16+ yrs | Gap | Ratio |
| 1920 | | | | | | | | |
| 25 | 0.03 | 0.035 | 0.005 | 0.87 | 0.018 | 0.024 | 0.006 | 0.74 |
| 30 | 0.06 | 0.08 | 0.02 | 0.72 | 0.03 | 0.04 | 0.01 | 0.74 |
| 40 | 0.17 | 0.26 | 0.09* | 0.68* | 0.10 | 0.19 | 0.09* | 0.53* |
| 50 | 0.34 | 0.49 | 0.15* | 0.70* | 0.22 | 0.33 | 0.11* | 0.69* |
| 1930 | | | | | | | | |
| 25 | 0.05 | 0.09 | 0.04* | 0.51* | 0.03 | 0.07 | 0.04* | 0.47* |
| 30 | 0.11 | 0.20 | 0.09* | 0.56* | 0.07 | 0.16 | 0.09* | 0.47* |
| 40 | 0.27 | 0.41 | 0.14* | 0.65* | 0.18 | 0.32 | 0.14* | 0.58* |
| 50 | 0.40 | 0.64 | 0.24* | 0.63* | 0.31 | 0.51 | 0.20* | 0.61* |
| 1940 | | | | | | | | |
| 25 | 0.08 | 0.14 | 0.06* | 0.57* | 0.08 | 0.15 | 0.07* | 0.51* |
| 30 | 0.15 | 0.26 | 0.11* | 0.58* | 0.13 | 0.27 | 0.14* | 0.49* |
| 40 | 0.30 | 0.48 | 0.18* | 0.62* | 0.24 | 0.48 | 0.24* | 0.50* |
| 50 | 0.46 | 0.65 | 0.19* | 0.71* | 0.39 | 0.64 | 0.25* | 0.60* |
| 1950 | | | | | | | | |
| 25 | 0.10 | 0.20 | 0.10* | 0.50* | 0.10 | 0.20 | 0.10* | 0.51* |
| 30 | 0.16 | 0.33 | 0.17* | 0.49* | 0.17 | 0.33 | 0.16* | 0.51* |
| 40 | 0.29 | 0.51 | 0.22* | 0.58* | 0.29 | 0.53 | 0.24* | 0.55* |
| 50 | 0.42 | 0.62 | 0.20* | 0.68* | 0.39 | 0.64 | 0.25* | 0.61* |
| 1960 | | | | | | | | |
| 25 | 0.10 | 0.21 | 0.11* | 0.49* | 0.11 | 0.25 | 0.14* | 0.44* |
| 30 | 0.16 | 0.32 | 0.16* | 0.52* | 0.17 | 0.39 | 0.22* | 0.44* |
| 40 | 0.28 | 0.50 | 0.22* | 0.56* | 0.29 | 0.56 | 0.27* | 0.52* |
| 1970 | | | | | | | | |
| 25 | 0.15 | 0.23 | 0.08* | 0.62* | 0.14 | 0.29 | 0.15* | 0.51* |
| 30 | 0.22 | 0.42 | 0.20* | 0.53* | 0.22 | 0.47 | 0.25* | 0.46* |

Notes: *indicates that gap is significantly different from zero or ratio is significantly different from unity at $p < 0.05$. Gap denotes % prevalence of college graduates minus <16 years group. Ratio denotes probability of <16 group over 16 + group.

Although in absolute terms educational differences in the cumulative probability of quitting increase over the life course for all cohorts, the pattern is different for relative differences in these probabilities. For both men and women in the 1920–1929 cohort, the ratio of the quitting probabilities decreased as the cohort aged, suggesting that relative inequalities in quitting increased over the life course. Men and women in this birth cohort were age 30–50 from 1950 to 1970, the period in which information about the negative health effects of smoking first became widely publicized. Although educational differences in quitting for this cohort were small at ages 25 and 30, educational differences in quitting widened at ages 40 and 50. In all subsequent cohorts, however, the ratio of quitting probabilities improves over the life course. Although the cumulative probability of quitting increases for both education groups over the life course, the relative inequality in these probabilities (measured by their ratio) narrows over the life course. Moreover, with just a few exceptions, trends in these ratios across the life course are fairly constant across cohorts.

### *The relative role of never smoking versus quitting*

The analyses so far show large educational gaps in never smoking, converging gaps in former smoking, and large but steady inequalities in the likelihood of quitting. How can differences in former smoking across the life course converge if differences in quitting do not converge? Educational inequalities in smoking depend both on differences in initiation and differences in quitting. Equation (1) shows how these components work together:

$$\%\text{Current}^{<16} - \%\text{Current}^{16+} = \left(\%\text{Never}^{16+} - \%\text{Never}^{<16}\right) + \left[\left(1 - \%\text{Never}^{16+}\right)\left(p(\text{quit})^{16+}\right) - \left(1 - \%\text{Never}^{<16}\right)\left(p(\text{quit})^{<16}\right)\right] \quad (1)$$

The difference in the percent prevalence of current smoking between those with less than college completed (<16 years) and college graduates (16+ years) is a function of educational differences in the prevalence of never smoking (initiation) and educational differences in the probability of quitting. The portion of the gap explained by differences in quitting is itself a function of educational differences in initiation. That is, educational differences in quitting are weighted by the share of ever smokers for each group. When educational differences in ever smoking are small, then differences in the probability of quitting account for the bulk of the observed educational gap in smoking. But as the share of never smokers among the highly educated increases, then differences in the probability of quitting apply to a smaller and smaller part of the population, and thus explain only a small part of the educational gap in smoking. Educational gaps in current smoking are produced by the *combination* of educational differences in never smoking and quitting.

It is this combination that produces the flat educational gradient in former smoking in more recent cohorts and periods. Because of the relatively low prevalence of ever smokers among college graduates, the prevalence of former smokers in this group is also fairly low, despite the fact that the highly educated have high quitting probabilities. In contrast, the share of ever smokers is much higher among those with less schooling but this group has lower quitting probabilities, which produces a low prevalence of former smokers for this education group as well. As a result, sizeable differences in quitting probabilities by education nonetheless produce similar numbers of "quitters" (former smokers) in the population. The share of the educational gap in smoking explained by differences in the probability of quitting is a direct function of educational inequalities in never smoking (initiation).

As Equation (1) shows, because these relationships are in part multiplicative, it is difficult to decompose the gap in current smoking into the part explained by never smoking versus the part explained by differences in quitting. The gap in current smoking depends on the covariance or interaction of these two factors. We can, however, consider a set of hypothetical comparisons that help quantify the relative role of these two components. Using the data shown in Table 2 and the 1950–1959 male birth cohort as a starting point, Table 5 shows the educational inequalities in smoking that would be predicted from different hypothetical combinations of never smoking levels and quitting probabilities.

The first row in Table 5 shows the observed data for the 1950–1959 male birth cohort as a reference point. Given its observed never smoking prevalence and quitting probabilities, this cohort had a 21 percentage point gap in current smoking at age 50 by education. If this birth cohort maintained its observed educational inequalities in quitting but had the prevalence of never smoking by education observed in the 1970 cohort, the expected gap in current smoking at age 50 would decline to 18 percentage points (row 2). Despite holding the observed educational inequalities in quitting constant, the gap in current smoking would decline because the observed quitting probabilities applied to a shrinking pool of ever smokers produces fewer former smokers, especially among the highly educated. If this cohort maintained its observed educational inequalities in quitting but we equalized the never smoking prevalence for both groups to that of the college graduates in the 1950 birth cohort, the gap in current smoking at age 50 would decline to 8 percentage points (row 3). If we did this same experiment but equalized the never smoking prevalence for both groups to the level of college graduates in the 1970 cohort, the gap in current smoking would shrink to only 5 percentage points (row 4). This would reduce the expected gap in current smoking by nearly 80% even though educational inequalities in quitting remained entirely unchanged.

Another way to assess the effect of differential quitting on educational gaps in smoking is to ask: what if there was no quitting at all for either education group? If we used the observed never smoking prevalence in the 1950 cohort but equalized the quitting probabilities for both groups to zero, the gap in current smoking would be 23 percentage points, which is even higher than the observed gap (row 5 versus row 1). In this case, we would eliminate the slightly higher prevalence of former smoking among men with less education. For this cohort, if there was no quitting at all, the gap in current smoking would be larger, not smaller. Educational differences in quitting over the life course increase inequalities in smoking only for those cohorts, such as the 1920 cohort, in which there was a much higher and more equal prevalence of ever smoking by education. If we used the observed never smoking prevalence of the 1920 cohort but eliminated all quitting for both education groups, the gap in smoking would shrink to 9 percentage points (row 6). In this case, we would eliminate the large advantage experienced by ever smoking college graduates in this birth cohort who quit smoking in their 40s. Although in both the immediately preceding examples quitting was equalized to zero for both education groups, these two examples give very different results due to the differences in initiation by education for each cohort.

These results, however, do not mean that educational differences in quitting do not matter for educational inequalities in smoking. Instead, they underscore the fact that the effect of differential quitting depends on educational differences in initiation. If we held the never smoking prevalence at the observed 1950 cohort level but equalized quitting to the probabilities observed for those with less than college completed, the gap in current smoking would shrink from 21 to 13 percentage points (row 7). In this case, we would decrease the expected share of former smokers in the population among college graduates and create a 10 percentage point advantage in the prevalence of former smokers for those with less than college completed. If we did this same exercise using the

**Table 5**
Smoking gaps predicted by different combinations of never smoking prevalence and quitting probabilities, NHIS.

| | Gap never | Gap former | Gap current |
|---|---|---|---|
| (1) 1950–1959 male birth cohort observed data at age 50 | 23 | −2 | 21 |
| (2) 1950 quitting; 1970 never prevalence | 23 | −5 | 18 |
| (3) 1950 quitting; equalize never to 1950 16+ yrs prevalence | 0 | 8 | 8 |
| (4) 1950 quitting; equalize never to 1970 16+ yrs prevalence | 0 | 5 | 5 |
| (5) 1950 never prevalence; equalize quitting to zero | 23 | 0 | 23 |
| (6) 1920 never prevalence; equalize quitting to zero | 9 | 0 | 9 |
| (7) 1950 never prevalence; equalize quitting to 1950 <16 yrs | 23 | −10 | 13 |
| (8) 1950 never prevalence; equalize quitting to 1950 16+ yrs | 23 | −14 | 9 |

Notes: computed from the data shown in Table 2.

quitting probabilities observed for college graduates in the 1950 cohort, the gap in current smoking would shrink to 9 percentage points (row 8). This would create a 14 percentage point advantage in the prevalence of former smokers among men with less than college schooling. The same quitting probability applied to a much larger share of ever smokers produces a larger share of quitters in the population. Finally, what if the quitting probabilities for both groups were equalized to one? In this case, there would be no educational difference in current smoking at age 50—there would be no current smokers for either group—but we would still have large inequalities in lifetime exposure to smoking due to differences in initiation by education. To summarize, educational inequalities in smoking would be reduced the most if we could increase the share of never smokers among those with less than college completed to the prevalence observed for college graduates in the 1970 birth cohort. If, however, educational gaps in never smoking remain at the observed levels, the educational gap in current smoking would also be smaller if individuals with less schooling had the quitting probabilities of college graduates. But even if all smokers quit regardless of education, we would still observe large inequalities in smoking exposure over the life course because of differences in never smoking regularly by education.

## Discussion

In order to show trends across many decades and cohorts, the analyses above necessarily make some simplifications. First, because comparable data on daily smoking and the number of cigarettes smoked were not available for all survey years, the analyses do not control for differences in these dimensions of smoking by education. Another limitation of taking the long view historically is that the selectivity of the education categories has changed over time. The analyses use a categorical definition of schooling that aims to minimize the effect of such selectivity. Nonetheless, college graduates were likely more positively selected in earlier periods and cohorts than more recent ones. These simplifications are offset by the advantages that come from studying disparities in smoking with large, representative samples of the U.S. population and over many decades and birth cohorts.

With these caveats in mind, the results show that educational differences in never smoking account for most of the educational gap in adult smoking. For men, this pattern emerged with the 1940–1949 birth cohort and has persisted from the mid 1960s to the present. For women, this pattern emerged with the 1950–1959 birth cohort and has persisted from the mid 1980s to the present. Although differences in quitting by education contributed to the initial emergence of educational gaps in smoking, differences in the prevalence of former smokers across the life course have converged. Similarly, educational differences in the cumulative probability of quitting across the life course have remained fairly constant over cohorts. In contrast, differences in never smoking by education have increased across birth cohorts.

Educational gradients in adult smoking are produced by the combination of educational differences in never smoking (initiation) and differences in quitting. The portion of the educational gap in smoking explained by inequalities in quitting itself depends on educational differences in never smoking. The population share of former smokers is a function both of quitting ratios and the prevalence of ever smokers by education. Given the patterns observed in recent birth cohorts, educational inequalities in current smoking would be reduced the most by increasing the prevalence of never smokers among individuals with less than college completed. Not only would this reduce the educational gap in current smoking by the largest share, but it would also dramatically reduce inequalities in smoking exposure over the life course.

The fact that educational disparities in adult smoking are tethered to differences in smoking initiation means that the relationship between education and adult smoking requires a life course perspective that reaches back to adolescence. The initiation of regular smoking generally occurs before school completion. Thus, the relationship between education and adult smoking is difficult to disentangle. The relationship between schooling and smoking may be confounded by factors such as social networks, aspirations, or time horizons; or, educational attainment and smoking may be jointly determined. Alternatively, we need to consider a different conceptualization of "education" than the standard concepts of years or level completed. Specific school experiences such as coursework, school policies, extracurricular activities, and other educational experiences might be more relevant components of the underlying relationship between schooling and smoking. To better understand the mechanisms relating education and adult smoking, we have to consider how specific school experiences shape the transition to regular smoking, net of a large set of potential confounders.

From the perspective of social disparities in health, understanding how educational gradients in smoking are produced advances our understanding of the social shaping of important health outcomes (Link, 2008). Theoretical perspectives on why educational gradients in health exist argue that those with more schooling have important skills and resources that help them secure or produce better health (Cutler & Lleras-Muney, 2010; Link, 2008; Link & Phelan, 1995). Although educational gradients in smoking are an undeniable marker of the social patterning of health inequality, our existing theories need refinement in the case of smoking. The fact that educational inequalities in current smoking and quitting depend on educational inequalities in initiation means that we cannot abstract from early life experiences even when describing health behaviors in adulthood. If education provides health-producing skills and resources that cause those with more schooling not to smoke, it would have to do so in adolescence and thus prior to school completion, in order to impact adult smoking status. This also suggests that the correct unit of analysis for having these education-related resources is likely not only the individual but also one's family of origin.

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## Appendix

**Table A**
Sample sizes for cohorts shown in Tables 2–4, NHIS.

| Cohort | Men | | Women | |
|---|---|---|---|---|
| | <16 years education | 16+ years education | <16 years education | 16+ years education |
| 1920–29 | | | | |
| Age 25 | 2690 | 587 | 3703 | 375 |
| Age 30 | 2690 | 587 | 3703 | 375 |
| Age 40 | 2690 | 587 | 3703 | 375 |
| Age 50 | 2635 | 572 | 3630 | 364 |
| 1930–39 | | | | |
| Age 25 | 5256 | 1574 | 7348 | 1152 |
| Age 30 | 5256 | 1574 | 7348 | 1152 |
| Age 40 | 5192 | 1555 | 7264 | 1138 |
| Age 50 | 2757 | 857 | 3851 | 666 |

**Table A** (*continued*)

| Cohort | Men | | Women | |
|---|---|---|---|---|
| | <16 years education | 16+ years education | <16 years education | 16+ years education |
| 1940–49 | | | | |
| Age 25 | 17,213 | 7280 | 23,315 | 6720 |
| Age 30 | 17,130 | 7245 | 23,195 | 6704 |
| Age 40 | 14,028 | 5955 | 18,930 | 5646 |
| Age 50 | 10,348 | 4320 | 13,998 | 4252 |
| 1950–59 | | | | |
| Age 25 | 31,009 | 12,351 | 40,212 | 13,964 |
| Age 30 | 28,692 | 11,542 | 37,083 | 13,139 |
| Age 40 | 23,513 | 9453 | 29,698 | 10,797 |
| Age 50 | 9133 | 3828 | 11,652 | 4362 |
| 1960–69 | | | | |
| Age 25 | 28,956 | 10,929 | 36,343 | 13,345 |
| Age 30 | 26,191 | 9920 | 32,460 | 12,176 |
| Age 40 | 10,709 | 4244 | 12,780 | 5134 |
| 1970–79 | | | | |
| Age 25 | 17,826 | 7588 | 22,928 | 9585 |
| Age 30 | 9746 | 4504 | 12,449 | 5629 |

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