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Do socio-economic gradients in smoking emerge differently across time by gender? Implications for the tobacco epidemic from a pregnancy cohort in California, USA

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Abstract

Understanding current patterns of population smoking by socioeconomic position (SEP) can be substantially enhanced by research that follows birth cohorts over long periods of time, yet such data in the US are rare. Information from birth cohorts followed during critical time periods when the health consequences of smoking became widely known can inform the ways in which current smoking prevalence has been shaped by the historical processes that preceded it. The present study utilizes data from a substudy of the Child Health and Development Study pregnancy cohort ($N=1612$). Women were queried about smoking status in 1959–1962, 1971–1972 and 1977–1980. Women were divided into three cohorts based on date of birth. Offspring represented another birth cohort assessed for smoking in 1977–1980. Results indicated that the overall prevalence of smoking exhibited cohort-specific patterns that persisted across time. Notably, the youngest maternal cohort (born 1937–1946) had high smoking prevalence throughout and showed no appreciable decrease (44.7%, 41.4%, 40.1% for 1959–1962, 1971–1972, and 1977–1980). Results also indicated that the relation of smoking to SEP exhibited cohort-specific patterns over time. Among the oldest birth cohort (born 1914–1930), no inverse relation of SEP to smoking was observed at any time; in contrast, an inverse relation emerged by 1959–1962 among the youngest cohort of mothers. Among the adolescent offspring, there was a strong SEP gradient ($OR = 2.0$, 95% $CI = 1.4–3.0$) that was stronger than in any maternal birth cohort at any assessment ($\beta = 0.40$, $SE = 0.1$, $p < 0.01$). We conclude that SEP gradients in smoking emerge across birth cohorts rather than time alone, with increasingly strong gradients across time especially among younger cohorts.

Keywords

U.S.; Gender; Socio-economic position; Smoking; Longitudinal studies; Birth cohort effects

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.socscimed.2012.10.011>.

Introduction

Understanding the health consequences of cigarette smoking has been one of the fundamental undertakings of epidemiologic research in the 20th century (Doll & Hill, 1954; Pearl, 1938), and the magnitude of the adverse effects of cigarette smoking on health continues to unfold (Doll, Peto, et al., 2004; Klebanoff, Levine, et al., 2001). While rates of smoking have declined in many high-income countries over the past thirty years (Pierce, 1989; Pierce, Messer, et al., 2011), a strong gradient in smoking by socioeconomic position (SEP) has simultaneously emerged in the U.S. as well as in many other high-income countries; low SEP is associated with higher probability of smoking (Chilcoat, 2009). Moreover, cigarette smoking in low-income countries is an increasing public health concern (Abdullah & Husten, 2004).

Despite an extraordinary body of research on cigarette smoking, there remain some fundamental gaps in our understanding of how health consequences of smoking arise across gender and socio-economic subgroups. An especially salient gap pertains to changes in cigarette smoking across birth cohorts of women in the 20th century, and the emergence of SEP gradients among women in these birth cohorts. These gaps hamper progress in the field by leaving open the question of how historical processes, policies, and norms shape cigarette consumption. As discussed by Lopez et al. (1994), countries often exhibit a predictable evolution of population-level tobacco use, with women consistently exhibiting lower overall prevalence, a lag in peak prevalence, and a slower decline compared to men. (Lopez, Collishaw, et al., 1994). This is evident in the US (Harris, 1983; National Cancer Institute, 1997) and other countries (Davy, 2006; Kemm, 2001). Data from repeated cross-sectional analyses of women indicate that prevalence of smoking increased among women of low socio-economic position during the 1970s and 1980s, during which time the prevalence of smoking among women with higher education and men with any education were leveling off or decreasing, both in the US (Escobedo & Peddicord, 1996) as well as Finland (Laaksonen, Uutela, et al., 1999) and the UK (Evandrou & Falkingham, 2002). Yet to our knowledge, no longitudinal cohort studies have examined evidence for birth cohort effects in the relation between SEP and smoking explicitly among women, during the pivotal period from 1960 to 1980, when the harmful effects of smoking became widely known.

A better understanding of the historical trends among women is critical for elaborating the implications of smoking for public health, developing policies to reduce smoking, and anticipating future trends in countries where smoking is on the rise. Evidence that rates of smoking initiation are now increasing among young women (Goodwin, Keyes, et al., 2009; Johnston, O'Malley, et al., 2007) further underscores the need to examine gender-specific smoking patterns. The present study utilizes a prospectively assessed sample of women representing various birth cohorts who were observed across 1959–1980 in the US. We use these data to examine trends by age, period, and cohort in cigarette smoking and in gradients by familial resources, as measured by husband's education, as a salient measure of SEP for this time period. Furthermore, to evaluate change across generations, we examine overall smoking prevalence and SEP gradient for the offspring of these women, interviewed in adolescence (age 15–18 years).

Methods

Study population and design

Data are drawn from the Child Health and Development Study (CHDS) (van den Berg, & Christianson, et al., 1988), the first large epidemiologic sample of pregnancies assembled and studied at a single site ($N = 20,754$). The CHDS included more than 95% of pregnant women receiving prenatal care in the Kaiser Permanente Health Plan and residing in the

East Bay Area of California from late 1959 to the fall of 1966. A broad range of SEP was represented, similar to that of the East Bay Area at the time of first data collection in 1959–1966, save the extremes (Krieger, 1992). The smoking prevalence among age and birth cohort strata of the CHDS sample were comparable to national averages derived from the NHIS (National Cancer Institute, 1997).

The present study focuses on a subsample of women and children who participated in a baseline survey from 1959 to 1962 and three follow-up assessments into the children's adolescence in 1977–1980 ($N = 1752$). Compared to the full CHDS sample, this subsample included a greater proportion of subjects whose mothers were married and living with a husband at the original intake, who were white, and who were high school graduates; it also includes a smaller proportion of first-born offspring. Detailed information can be found elsewhere (van den Berg, 1984; Keyes, Keyes, et al., 2011). Women who reported abstaining from smoking solely because of pregnancy were excluded ($N = 140$) for a final sample of 1612 women and their children.

Measures

Smoking—Women were queried regarding quantity and frequency of cigarette smoking at the pregnancy interview (1959–1962) and two follow-up assessments in 1971–1972 and 1977–1980. Self-reported smoking during pregnancy was highly correlated with serum cotinine levels during pregnancy (English, Eskenazi, et al., 1994). Offspring were asked about quantity and frequency of smoking status at the adolescent interview. Individuals were considered current smokers if they reported any use of cigarettes at the time of the interview; pack-a-day smoking was defined as an average of 20/day.

Socioeconomic position—For a single stable measure of familial SEP that would reflect familial resources, we used husband's education at the baseline interview and categorized it as less than high school ($N = 236$), high school ($N = 456$), or more than high school ($N = 920$). Sensitivity analyses were conducted using alternative measures of familial resources: husband's income [which had reduced power due to substantial missing data of 9.8%] and husband's occupation [manual/non-manual], and results were unchanged. We chose husband's education over women's own education as an indicator of familial resources because 96.4% of women were married at the baseline survey, and 60.1% reported that they were not involved in an independent career outside the home at the baseline survey. Furthermore, husband's education was remarkably stable across time; e.g., among those with less than a high school education at baseline, 92.7% reported less than a high school education 20 years later, while women's changed substantially over time (women increased educational attainment across the survey waves). Thus husband's education was a more valid and more stable indicator of familial resources than women's education. We recognize, however, that women's education is an important indicator of other dimensions of SEP. Sensitivity analyses using women's educational level are reported in the results.

Birth cohort—Each woman's year of birth was derived by subtracting her current age from the year of the baseline interview (1959–1962) yielding a range of 1914–1945. Using this information we estimated three cohort groups of mothers: 1937–1946, 1931–1936, and 1914–1930, to reflect early (age 15–23), average (age 24–31) and later child-bearing years (age 32–47), respectively. These categories were based on distributions in the data. Because the age ranges of cohorts across surveys were not directly comparable, we conducted sensitivity analyses matching age groups as closely possible across the baseline and final follow-up survey. Women who were <20 at the baseline interview were directly compared to the adolescent offspring (age 15–18); women who were 30–39 and 40–49 at the baseline interview were compared to women ages 30–39 and 40–49 at the 1977–1980 interview,

respectively. Women who were 20–29 at baseline or over 50 at the 1977–1980 interview had no comparison group.

Analysis—First, we examined trends in the prevalence of cigarette smoking across ages, periods, and birth cohorts. Next, we examined the relationship between familial SEP and smoking within each cohort at each of the three time periods of assessment, in order to determine whether SEP gradients in smoking emerged across time in a cohort-specific manner. We estimated the odds of smoking compared to a referent category of more than high school education, within each birth cohort at each time period. Analyses controlled for sex, race, age, and maternal smoking at previous time points. Analyses of adolescents additionally controlled for mother's birth cohort. We tested for trend by examining education as a continuous variable predicting the odds of smoking in each cohort. We conducted three additional analyses: 1) direct comparison of the proportion of individuals currently smoking who were the in the same age category but different birth cohorts between the baseline survey and the 1977–1980 follow-up; 2) the relation between SEP and pack-a-day smoking within each birth cohort at each time period; and 3) the relation between women's education and smoking. Pack-a-day smokers were compared to never smokers, limiting the sample size for analyses to 1151. All analyses were completed using SAS 9.2.

Results

Demographic characteristics described in detail elsewhere (Keyes, Keyes, et al., 2011). Briefly, 76% of the adolescent children were non-Hispanic White, 19.4% Black, and 50.3% were male. Over half (57%) had fathers who received more than a high school education at the time they were born; 28.3% had fathers with a high school education, and 14.7% had fathers with less than a high school education.

Trends in the prevalence of cigarette smoking across age, periods, and birth cohorts

Fig. 1 shows the prevalence of smoking across ages, time periods, and birth cohorts. Smoking prevalence was higher in younger born cohorts, regardless of age and time period. The adolescent offspring born 1959–1962 had a lower smoking prevalence (16.8%) than their mothers.

When compared directly to women who were younger than 20 during the time of pregnancy ($N = 60$), the prevalence of smoking was substantially lower in adolescents (16.8%) than in mothers (50.0%) (see Online Table 1). When those aged 30–39 at baseline were compared to those aged 30–39 in 1977–1980, smoking prevalence was markedly higher in 1977–1980 (29.1% vs. 47.8%), reflecting both the high prevalence of smoking among those women in pregnancy and the persistence of smoking across time.

Prevalence of smoking did not markedly decrease across time within the three birth cohorts of mothers. There was a modest decrease in smoking in the middle and oldest cohorts between 1959–1962 and 1971–1972, but the decrease then leveled off. Additional analyses revealed that in the cohort as a whole, few women started smoking after baseline (4.1%, $N = 72$) whereas more women quit smoking after baseline (11.1%, $N = 194$).

Trends in the SEP gradient in current cigarette smoking across age, periods, and birth cohorts

Fig. 2 and Table 1 display trends in the SEP gradient in smoking by age, period, and birth cohort. There is no signal of an SEP gradient at any time point in the oldest birth cohort (born 1914–1930).

Among the cohort born 1931–1936, the pattern in Fig. 2 suggests that those in the lowest SEP category were the *least* likely to smoke in 1959–1962 and the *most* likely to smoke in 1977–1980, suggesting the emergence of a gradient. Table 1 confirms a statistically significant trend (beta [β] = 0.25, SE = 0.1, p = 0.03).

Among the youngest cohort of mothers (born 1937–1946), the pattern suggests a gradient beginning in 1959–1962, continuing through each assessment time point, in 1971–1972 and 1977–1980. Table 1 indicates statistically significant trends for this cohort at the 1959–1962 (β = 0.34, SE = 0.2, p = 0.04) and 1977–1980 interviews (β = 0.33, SE = 0.2, p = 0.04), and a trend in the same direction at the 1971–1972 interview (β = 0.26, SE = 0.2, p = 0.10).

Among adolescent offspring assessed in 1977–1980, there is a marked socioeconomic gradient; those in the lowest SEP have approximately 2.0 times the odds of smoking compared to those in the highest SEP (OR = 2.04, 95% CI = 1.41–2.99), and the trend was significant as well (β = 0.4, SE = 0.1, p < 0.01). Results were robust when additionally controlled for maternal birth cohort (B = 0.42, SE = 0.1, p < 0.01).

Women's education as a marker of familial SEP

We conducted additional analyses using women's education level at the pregnancy interview (Online Fig. 1). While the oldest cohort of women does not demonstrate gradients by education level at any time point, all other cohorts descriptively show socio-economic gradients at all time points. Gradients among the 1931–1936 cohort are clear at each successively higher level of education, whereas for women in the youngest cohort of mothers (born 1937–1946), there differences emerge only among those with more than a high school degree.

Trends in the socioeconomic gradient in pack-a-day smoking across age, periods, and birth cohorts

The patterns for pack-a-day smoking compared to never smoking were overall very similar to those for any smoking (Online Table 2), although reduced power due to rarity of pack-a-day smoking (10.4%) precluded firm conclusions based on statistical significance.

Discussion

Given the paucity of evidence on smoking patterns over time focused on women, the present paper aimed to examine the emergence of socioeconomic gradients in smoking among women across multiple birth cohorts over the 20th century. Four central findings emerge. First, birth cohorts had specific smoking patterns that persisted across time, and more specifically, among the mothers, more recently-born cohorts of women had a high prevalence of smoking at every age across time than older cohorts of women. While more recently born cohorts of women could have higher prevalence of smoking due to developmental age differences (e.g., women in the youngest cohort were ages 15–23 years during pregnancy when smoking rates are typically high), we document that the smoking patterns remain cohort-specific throughout each group as they age, suggesting an underlying cohort effect rather than age effects alone. Cohort effects in smoking among women have been previously documented in the US and elsewhere (Davy, 2006; Harris, 1983; Kemm, 2001; Laaksonen, Uutela, et al., 1999; National Cancer Institute, 1997). The present study documents this effect using longitudinal data on the same women observed over time, an advance over previous studies of women in this time period.

Second, we document high rates of smoking in pregnancy in 1961–1963, especially among young women, with little evidence for abatement in smoking prevalence across time. This indicates that women did not substantially reduce smoking as social awareness of adverse

health effects increased in the United States following the publication of the Surgeon General's report in 1964 (Brandt, 2007). Young women showed the least reduction in smoking over this period. This stands in marked contrast to results among men, which show substantial decreases in smoking across a similar time period (Doll & Hill, 1954; Doll, Peto, et al., 2004; National Cancer Institute, 1997). This underscores the differences in societal influences on smoking across gender, and supports evidence that the population-level smoking experience for women is markedly different than for men (Lopez, Collishaw, et al., 1994).

Third, these data provide a novel perspective on the emergence of the SEP gradient in smoking across the 20th century in the US: SEP gradients in smoking emerged across birth cohorts rather than time periods alone. An influential body of work has interpreted the SEP gradient in cigarette smoking that emerged across the 20th century from a 'fundamental cause' (Link & Phelan, 1995) perspective of health and wellness: as new information about the consequences of a health behavior (i.e., smoking) becomes available, those of higher SEP will have more resources to enact positive behavior change, creating health disparities by SEP. These data suggest that although uptake of health information may be one of the mechanisms through which smoking decreased in the US, it is not a sufficient explanation for the decrease, because time trends in smoking differed markedly by gender across time, whereas awareness of the adverse effects of smoking showed similar time trends by gender across time (Brandt, 1996; Pacheco, 2011).

Fourth, we document the emergence of a strong SEP gradient among the adolescent offspring of these women, across all birth cohorts. National surveillance data indicates that smoking among adolescent girls decreased markedly across the 1970s and 1980s (Department of Health and Human Services, 2001; Gilpin, Lee, et al., 2005; Johnston, O'Malley, et al., 2007); our study results show that adolescents in the late 1970s and early 1980s were substantially less likely to smoke than their mothers, but that those with the least familial resources were twice as likely to smoke than those with the most familial resources.

While our main results used husband's education as a marker of familial SEP, we also document cohort effects on the relation between SEP and smoking when using women's own education. In fact, gradients emerged sooner and among older birth cohorts when examined by women's education, and our evidence indicates that women with more than a high school education were especially protected from smoking onset and persistence. Women's education in 1961–1963 likely also reflects factors such as SEP of the family of origin, cognition, literacy, and historical gender norms regarding educational attainment, as fewer women pursued higher education than men in this time period. Thus, these results suggest that highly educated women were especially protected from smoking onset and persistence.

Overall, these results are consistent with data from European countries, which have also documented that socioeconomic gradients in smoking are slower to develop among women compared to men (Evandrou & Falkingham, 2002; Graham, 2009; Huisman, Kunst, et al., 2005). However, we note that these studies use women's own education or employment grade as a marker for SEP; we find that the emergence of SEP gradients differs by women's education and their husband's education. Using women's own education, gradients emerged more quickly in smoking status; using husband's education, which is arguably a more robust indicator of familial resources, gradients emerge more slowly. Thus, these results may have implications for the study of tobacco use worldwide, and suggest that gender should be considered an important aspect of how smoking patterns are shaped at the population level.

Recent literature indicates a concerning growth in the incidence of lung cancer among young women in recent years (Levi, Bosetti, et al., 2007). Furthermore, it is now widely reported that conditional on smoking patterns, women have higher rates of lung cancer than men, suggesting a greater susceptibility to the adverse effects of tobacco (Cohn, Wingard, et al., 1996; Henschke, Yip, et al., 2006; Zang & Wynder, 1996). While men remain more likely than women to smoke in most low-income countries within which smoking overall is increasing, these collective results underscore that the cigarette smoking experience and the attendant consequences differ for women. A focus on women in research design and practice as well as public health prevention and intervention efforts is warranted.

The strengths of this study include its prospective design, population-based sample providing data comparable to data providing information on national averages of smoking, and comprehensive measures of maternal and offspring smoking across key time points in the sociological history of smoking in the US. Inference from the study is limited by the self-report of the respondents regarding smoking. However, validation analysis in this sample indicated strong associations between self report and serum cotinine (English, Eskenazi, et al., 1994). Bias due to under-reporting of smoking is likely most apparent in the adolescent sample, when smoking was more socially non-normative. Moreover, the present report includes current smoking and quantity of smoking, but we did not have sufficient power to separate SEP gradients in cessation versus initiation, as not enough individuals in this sample quit. Finally, we note that this sub-sample of the CHDS comprises women who were more likely to be White, married, high school graduates, and multiparous than the total pregnancy sample. Generalizability of these results to populations with different demographic characteristics is limited, given that smoking patterns differ substantially for racial/ethnic minorities and by marital and educational status (Grant, Hasin, et al., 2004).

In conclusion, the present study demonstrates the importance of birth cohort effects as well as gender as drivers of socioeconomic disparities in health. Cigarette smoking continues to be among the leading causes of preventable morbidity and mortality worldwide (World Health Organization, 2009), and the gap in cigarette smoking and related health problems between those with high versus low SEP is widening (Meara, Richards, et al., 2008). These results highlight the importance of considering social position when developing public health prevention efforts in order to prevent death and disability among the most vulnerable in the population, and the importance of considering birth cohort effects when examining trends over time in health disparities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Fig. 1.

Proportion of current smoking by age, period, and birth cohort among a pregnancy cohort of women and their offspring, first sampled in 1961–1963.

Fig. 2.

Proportion currently smoking by socio-economic position in 1961–1963: trends by birth cohort, age, and time period among a pregnancy cohort of women and their offspring, first sampled in 1961–1963.

Table 1

Odds ratios for the effect of socio-economic position on cigarette smoking by age, period, and birth cohort among a pregnancy cohort of women and their offspring, first sampled in 1961–1963.

Cohort 1: born 1914–1930 (N= 627)									
Time period		1959–1962		1971–1972		1977–1980			
Age		32–47		42–58		47–67			
N		OR (95% C.I.)	AOR (95% C.I.)	OR (95% C.I.)	AOR (95% C.I.)	OR (95% C.I.)	AOR (95% C.I.)	AOR (95% C.I.)	
105	Less than high school	1.16 (0.7–1.9)	1.28 (0.8–2.1)	1.27 (0.8–2.1)	1.33 (0.8–2.3)	1.14 (0.7–1.9)	1.11 (0.6–1.9)		
142	High school	1.13 (0.7–1.7)	1.17 (0.8–1.8)	1.13 (0.7–1.8)	1.17 (0.7–1.9)	1.23 (0.8–2.0)	1.24 (0.8–2.0)		
380	More than high school	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
<i>Test for trend</i>		$B = -0.13, SE = 0.1, p = 0.30$		$B = 0.10, SE = 0.1, p = 0.42$		$B = -0.34, SE = 0.2, p = 0.02$			
Cohort 2: born 1931–1936 (N= 558)									
Time period		1959–1962		1971–1972		1977–1980			
Age		24–31		34–43		39–52			
N		OR (95% C.I.)	AOR (95% C.I.)	OR (95% C.I.)	AOR (95% C.I.)	OR (95% C.I.)	AOR (95% C.I.)	AOR (95% C.I.)	
75	Less than high school	0.70 (0.4–1.2)	0.76 (0.4–1.3)	1.23 (0.7–2.1)	1.23 (0.7–2.1)	1.37 (0.8–2.3)	1.33 (0.8–2.3)	1.33 (0.8–2.3)	
137	High school	0.96 (0.6–1.5)	1.01 (0.7–1.6)	1.33 (0.9–1.0)	1.33 (0.9–2.0)	1.38 (0.9–2.1)	1.37 (0.9–2.1)	1.37 (0.9–2.1)	
346	More than high school	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
<i>Test for trend</i>		$B = -0.14, SE = 0.1, p = 0.29$		$B = -0.14, SE = 0.1, p = 0.25$		$B = 0.25, SE = 0.1, p = 0.03$			
Cohort 3: born 1937–1946 (N= 423)									
Time period		1959–1962		1971–1972		1977–1980			
Age		15–23		25–34		30–43			
N		OR (95% C.I.)	AOR (95% C.I.)	OR (95% C.I.)	AOR (95% C.I.)	OR (95% C.I.)	AOR (95% C.I.)	AOR (95% C.I.)	
56	Less than high school	1.84 (1.0–3.4)	1.91 (1.0–3.6)	1.51 (0.8–2.8)	1.55 (0.8–2.8)	1.61 (0.9–2.9)	1.63 (0.9–3.0)		
177	High school	1.31 (0.9–2.0)	1.50 (1.0–2.3)	1.20 (0.8–1.8)	1.29 (0.8–2.0)	1.39 (0.9–2.1)	1.46 (1.0–2.2)		
190	More than high school	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
<i>Test for trend</i>		$Beta = 0.34, SE = 0.2, p = 0.04$		$Beta = 0.26, SE = 0.2, p = 0.10$		$Beta = 0.33, SE = 0.2, p = 0.04$			
Cohort 4: born 1959–1962 (N= 1,612)									
Time period		1977–1980		1977–1980		1977–1980			
Age		15–18		15–18		15–18			
N		OR (95% C.I.)	AOR (95% C.I.)	OR (95% C.I.)	AOR (95% C.I.)	OR (95% C.I.)	AOR (95% C.I.)	AOR (95% C.I.)	

Less than high school	236	2.22 (1.57–3.15)	2.04 (1.41–2.99)
High school	456	1.51 (1.11–2.05)	1.37 (1.00–1.89)
More than high school	920	1	1
<i>Test for trend</i>		Beta = 0.40, SE = 0.1, $p < 0.01$	

AOR: Adjusted odds ratio; adjusted for offspring sex, race, age, and maternal smoking at previous time points.
All betas in tests for trend controlled for offspring sex, race, age, and maternal smoking at previous time points