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Life course socioeconomic conditions, passive tobacco exposures and cigarette smoking in a multiethnic birth cohort of U.S. women

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Abstract

Low socioeconomic status (SES) and exposure to passive tobacco smoke are associated with increased risk of smoking in adults, but the influences of these factors in earlier life periods on adult smoking behavior are not well understood. We investigated the relationship of SES and passive tobacco exposure over the lifecourse with adult smoking status in a multiethnic cohort of U.S. women ($n = 262$, average age = 41.8), using prospective data on maternal smoking during pregnancy and childhood SES, and follow-up data on current smoking, adult SES and household tobacco exposure. Low adolescent and adult SES consistently increased the risk of current smoking, but most associations were not statistically significant in multivariable models. Blue collar parental occupation at birth increased the risk of smoking, particularly for current smoking relative to former smoking (odds ratio [OR] = 2.7, 95% confidence interval [CI] = 1.2–5.9). After adjusting for SES, current and former smokers were more likely than never smokers to have exposures to prenatal tobacco (OR = 4.4, 95% CI = 2.1–9.4 and OR = 2.0, 95% CI = 1.0–4.2, respectively) and adult household tobacco (OR = 2.7, 95% CI = 1.3–5.8 and OR = 2.4, 95% CI = 1.2–4.8, respectively). Our results show that early life conditions have enduring influences on women's smoking behavior in middle adulthood, even after considering similar types of conditions in later life periods.

Keywords

Smoking; Life course; Socioeconomic factors; Passive or secondhand smoke; Ethnicity

Introduction

In the United States (U.S.) and many western countries, cigarette smoking is more concentrated among adults from more disadvantaged socioeconomic circumstances [1–4], a pattern that is observed for both men and women, and major racial/ethnic populations in the U.S. [5]. However, it is less clear whether socioeconomic status (SES) in earlier life periods has an enduring influence on smoking behavior of adults.

Research findings examining the influences of SES at different life periods on adult smoking have been mixed with a few studies showing independent associations with childhood and adult SES [6–8] and others finding no or weak associations between childhood SES and

smoking after accounting for adult SES [9-16]. Evidence also suggests that childhood SES may contribute more significantly to smoking behavior among women than men [7-10]. Women's smoking status may also be influenced by a different set of socioeconomic conditions. For example, parenting and partnering circumstances have shown stronger and more consistent associations with smoking status in women than in men [7, 11, 17].

Since low SES is associated with higher smoking prevalence, lower SES groups may be disproportionately exposed to passive tobacco smoke, also known as environmental tobacco smoke (ETS), and this exposure may accumulate throughout the life course. Smoking by parents, peers, and partners has consistently been found to increase the likelihood of smoking and decrease the likelihood of cessation [11, 18, 19]. Additionally, maternal smoking during pregnancy or prenatal tobacco smoke (PTS) has been shown to influence smoking behavior among the offspring [20-24]. However, no study has examined the influences of passive tobacco exposure across the life course, beginning with in utero exposure, on adult smoking behavior. Furthermore, although studies investigating the association of ETS or PTS with smoking behavior have often adjusted for SES measured in one life period, none has considered SES at multiple life periods. Here, we examined whether socioeconomic circumstances as well as passive tobacco exposures across the life course influenced women's mid-life smoking status in a multiethnic U.S. birth cohort.

Materials and methods

Sample

The study sample included female participants of the National Collaborative Perinatal Project (NCP), who were born in New York City, prospectively followed until age 7, and traced and enrolled in an adult follow-up study between 2001 and 2006 (average age at follow-up = 41.8 years $\pm$ SD = 1.82, range: 38–46). Of the 841 eligible women, 375 (45%) were traced, and 262 of those traced (70%) were enrolled in follow-up studies (see reference for further detail) [25, 26]. Based on adult self-reports, the sample was 38% Hispanic, 36% non-Hispanic African American and 26% non-Hispanic White.

Data collection

Early life data used in this study were prospectively collected via interviews with mothers or other caregivers of the child participants at two time points: during mother's pregnancy and enrollment into the study (referred to as the birth time point) and at the seven-year follow-up. Because SES at birth and age seven were correlated ($r = 0.60$, $p < 0.0001$ for SES summary measures), and this information was more complete at birth than at age 7, we used SES at birth. Adult data were collected through a self-administered questionnaire.

Measures

Smoking status—Participants provided information on their past and current smoking participation (based on C1 cigarette per day for one month or longer), number of years smoked, age at initiation, average daily cigarette consumption, and age at cessation if applicable. Participants were categorized into never smokers, former smokers (those with a history of smoking but not currently smoking), and current smokers. To distinguish between brief smoking experimentation and established smoking, we classified as never smokers two participants who reported smoking for less than a year. All former smokers had quit for at least one year before the follow-up survey.

Socioeconomic status—Maternal education at birth was based on the number of completed years of education and categorized into less than high school (B11 years), high school graduate (12 years), and more than high school education (C13 years). Adult

education data on the highest degree earned were divided into three categories of high school or less, technical/vocational training or some college, and college or higher degrees. Parental occupation was based on father's occupation with mother's occupation used when fathers were absent, unemployed or lacked occupational data. Adult occupation was determined from open-ended reports of participant's current occupation, or last occupation if currently unemployed. Participants who were never employed (2%) or whose parents were unemployed at birth (2%) were excluded from the analyses using occupational data. Both parental and participant's own occupations were classified into blue collar (e.g., crafts and kindred workers, laborers, transportation operatives) and white collar (e.g., managers, teachers, nurses) based on industry and required skills. Family per-capita income was assessed at birth in dollar amount ranging from 0 (no income) to \$6,000. Adult household income was reported in 12 categories ranging from less than \$5,000 to more than \$130,000. These income variables were divided into three categories of approximately equal distribution.

Family structure was measured through maternal report of the presence of both parents at home at birth, and through participant's retrospective self-report for age 13. Because few participants (9%) had single-parent family structure at birth, we limited our analyses to age 13. Early motherhood was defined as having given birth to a child before age 21. Single motherhood was defined by reports of currently living with at least one child and having a current marital status that did not include being married or living with a partner.

Passive tobacco exposures—Information on maternal smoking during pregnancy (current smokers vs. current nonsmokers) was obtained from the mothers when they were pregnant with the offspring in the study. Asked in the adult follow-up survey, ETS in childhood and adult life was assessed by self-reported presence of smokers in the home during these life periods.

Data analysis

We used unordered polytomous logistic regression to simultaneously assess differences across three levels of smoking status, and to produce odds ratios (ORs) [27]. Because ORs can be substantially overestimated when dealing with common outcomes, we also conducted Poisson regression with robust error variance to estimate the relative risk (RR) of smoking in relation to SES and passive smoke [28]. Here, we present polytomous regression results, because while estimated ORs were larger than RRs, the overall inferences were similar. Only variables with statistically significant associations (at $p = 0.05$) with smoking status at the univariable level were included in the multivariable models.

Results

Fifty-three percent of participants were smokers, with nearly half having quit, on average, 12 years before the adult survey (± 6.69 , range: 1–26). Current and former smokers did not differ in average age at smoking initiation (15.9 vs. 16.1 years, respectively) and average daily number of cigarettes smoked (11.4 vs. 11.2, respectively). The prevalence of lifetime smoking was lowest for African Americans (42% vs. 64% for whites and 55% for Hispanics), while the quit ratio (proportion of smokers who were former smokers) was highest for whites (59% vs. 48% for African Americans and 45% for Hispanics).

In univariable analyses (Table 1), maternal education and family income at birth were not associated with smoking status. For the remaining SES indicators, adverse conditions were more prevalent among current smokers than former and never smokers, with most associations reaching statistical significance. Passive tobacco exposures increased the risk of smoking, with the associations for current smoking relative to never smoking being

particularly strong for PTS (Odds ratio [OR] = 4.6, 95% confidence interval [CI] = 2.4–8.7) and adult ETS (OR = 3.6, 95% CI = 1.9–6.8). Participants who reported living with a smoker as children were not significantly more likely to be smokers than those without this exposure.

In multivariable models (Table 2), having a parent employed in a blue collar occupation was associated with an increased probability of being a current smoker relative to a former smoker (OR = 2.7, 95% CI = 1.2–5.9). The associations between PTS and smoking status remained after adjusting for childhood and adult SES, and ETS in adult life (e.g., OR = 4.4, 95% CI = 2.1–9.4, and OR = 2.2, 95% CI = 1.0–4.9 for current vs. never smoking and current vs. former smoking, respectively; OR = 2.0, 95% CI = 1.0–4.2 for former vs. never smoking). Adjusting for SES and PTS lessened the odds of current smoking relative to never smoking for exposure to adult ETS, but did not affect the other comparisons. African Americans, as compared with whites, had a lower probability of current (OR = 0.3, 95% CI = 0.1–0.8) and former (OR = 0.2, 95% CI = 0.1–0.6) smoking relative to never smoking.

Discussion

Current smokers had more adverse socioeconomic circumstances and greater exposure to passive tobacco smoke across the life course than women who never smoked or quit smoking. In contrast, nonsmokers and former smokers had a similar socioeconomic profile, and differed mainly on their racial/ethnic background and passive tobacco exposures. This may suggest that factors related to one's ethnic background and family environment, rather than socioeconomic conditions may facilitate smoking in some women; however, these women are more successful in quitting than smokers facing socioeconomic disadvantage.

We compared current and former smokers by age at smoking initiation and average daily cigarette consumption, two factors related to the degree of smoking addiction and likelihood of quitting, and observed no significant differences [29–32]. Additionally, age at initiation and average daily cigarette consumption did not differ by SES in any consistent manner (data not shown), suggesting that overall participation in smoking, rather than specific aspects of smoking, may be the key outcome to be addressed for reducing socioeconomic disparities in smoking.

We observed notable racial/ethnic differences in smoking habits. As compared with white women, African Americans, and to a lesser extent, Hispanics had a lower likelihood of lifetime smoking but also a lower likelihood of smoking cessation. National surveys of adult U.S. women have found similar or higher prevalence of current smoking among African Americans and lower lifetime and current smoking prevalence among Hispanics, as compared with whites [3]. However, these prevalence patterns vary substantially by sociodemographic factors including age, geography, nativity, and acculturation [33–39]. For example, among Hispanic American women, smoking prevalence is higher among Puerto Ricans (which formed 60% of the Hispanic participants in our study,) and those who are born in the U.S [34, 39]. Prior research findings appear consistent with regard to the lower cessation success among racial/ethnic minorities [32, 40–42]. Accounting for life course SES and passive tobacco exposure reduced the African American-white differences between current and former smokers in our cohort, but did not affect the same differences for Hispanic and white women. These findings suggest that smoking trajectories and their associations with life course SES and other conditions may be patterned by race/ethnicity.

Life course socioeconomic influences

The overall results showed that socioeconomic influences on adult women's smoking status are not confined to any particular life period. The SES profile of current smokers diverged

from former and never smokers beginning in the early childhood period and continued through adolescence and into middle adulthood.

The only significant childhood SES difference was found between former and current smokers. The relatively greater importance of childhood SES to cessation than initiation was also suggested by two recent studies. First, among women in five western European countries, manual parental occupation was associated with reduced odds of quitting after adjusting for adult SES, although this association did not hold for U.S. women from California's Alameda county [9]. In another study of a prospective British cohort similar in age to our cohort, manual paternal occupation, but not own occupation, resulted in widening of the socioeconomic gradient in smoking in mid-life [43].

Adolescent and adult SES indicators consistently increased the risk of current smoking, but in adjusted models only income and early motherhood were marginally significantly associated with current smoking. Corroborating findings from other research, our results highlight the important contribution of early motherhood, and to a lesser degree lone motherhood, to increased likelihood of smoking and decreased likelihood of quitting [7, 16, 17, 31]. Through limiting educational and economic possibilities, early motherhood is strongly intertwined with women's future socioeconomic standing. In our cohort, those who became young mothers were significantly less likely to have college or higher degrees (17% vs. 50%), higher adult income (29% vs. 52%), or employment in a white collar occupation (46% vs. 64%). However, the influence of early motherhood on smoking appeared to be independent of educational attainment and current family income. Early motherhood may relate to domestic and reproductive dimensions of SES (e.g., parenting stress and limited resources during adolescence and early adulthood), which are not adequately captured by conventional SES measures including current income and occupation and final educational attainment [17, 44, 45].

Smoking habits are often established before completion of formal education or entrance into the labor market [46] and adolescent smoking has been found to be more strongly associated with own educational attainment, employment status, and occupational standing in early adulthood than with childhood/parental SES [14, 47-49]. It may therefore be argued that smoking affects socioeconomic trajectories, such that those who smoke have fewer opportunities for future advancement. However, equally plausible is that childhood circumstances influence the uptake of smoking during adolescence and early adulthood, which then independently or together with smoking, will also contribute to future adult socioeconomic standing. Our findings with respect to the role of parental occupation at birth and family structure at age 13 suggest that socioeconomic circumstances in early life do indeed contribute to the development of persistent smoking in middle adult life independent of adult SES.

Our participants reached adolescence in the late 1970s, when smoking rates began to fall more rapidly among higher than lower SES groups in the U.S. [1]. Given that socioeconomic differences in smoking prevalence in the U.S. and much of Europe are increasing with advancing age within birth cohorts as well as across successive birth cohorts [50-54], we predict that the SES differences in current smoking may widen as our cohort ages and may be larger in younger birth cohorts.

Life course passive smoking exposures

The strong association between exposure to PTS and the offspring's risk of smoking observed in our study is consistent with other research in the area [21, 23, 24, 55], including another long-term follow-up study of members of the Rhode Island NCPP cohort [20]. However, we did not find a significant influence on smoking behavior from household

tobacco exposure in childhood. Studies that have accounted for both maternal smoking during pregnancy and at times other than pregnancy have mainly found both exposures to, independently or in combination with each other, increase the risk of smoking by the offspring. [22-24, 56-58]. There are several possible explanations for the stronger association of smoking with PTS than with childhood ETS in our study. First, our measure of childhood ETS was self-reported by adult participants and did not specify any specific period of childhood. In contrast, PTS was measured at the time of pregnancy and was reported by mothers themselves. The greater potential for non-differential measurement error for childhood ETS may have attenuated any association between this exposure and smoking status. Second, gender differences in the influence of parental smoking have been noted with maternal smoking in childhood being more strongly associated with smoking behavior of female offspring than paternal smoking [7, 24, 59]. Although maternal smoking may have continued postnatally in our cohort (more than 97% of women with PTS also reported childhood exposure to household tobacco smoke), childhood ETS was far more common than PTS and likely captured smoking by fathers and other adults in the household with a weaker influence on smoking behavior of female offspring. To further tease apart maternal smoking during and after pregnancy, we examined the association between childhood ETS and smoking status among participants whose mothers did not smoke during pregnancy, and did not find any significant association between childhood ETS and adult smoking (data not shown). Finally, because nicotine and other compounds in tobacco can cross the placental barrier, PTS likely captures direct fetal exposure to tobacco, which may modify the developing fetal brain or hormonal levels and increase the probability of experimenting with and/or developing smoking addiction in the offspring [22, 55]. Support for a physiological link between smoking and PTS is found in research demonstrating the specificity of the PTS relationship with offspring cigarette smoking behavior, and not the use of other substances including alcohol and marijuana [20, 57]. While our study does not address the mechanism linking PTS to adult offspring smoking, our findings suggest that in addition to garnering more immediate health benefits to the mother and her newborn, efforts to reduce pregnant women's smoking may improve the long-term health of the offspring by decreasing their lifetime risk of smoking.

Women who never smoked were less likely to report living with smokers as adults than current and former smokers, while no differences in adult household exposure to ETS were found between the two groups of smokers. We expected a greater exposure to adult household tobacco exposure among current smokers mainly for two reasons. First, household and other environmental restrictions on smoking are important predictors of smoking cessation [60,61]. Second, even among smokers, those with higher SES (in our cohort, the former smokers) have been found to impose greater restriction on smoking in the home than those of lower SES [62]. However, our measure of household ETS was imprecise with respect to the timing of this exposure and may not have reflected recent or current living situations, with possibly greater impact on quitting chances.

Methodological considerations

We used prospectively collected information on maternal smoking during pregnancy and childhood SES, but were limited to retrospective reporting of childhood ETS, family structure at age 13, and smoking history. Self-report of smoking status has shown adequate validity in population-based studies [63], with no significant reporting bias by socioeconomic status [64, 65]. Maternal reports of their smoking status during pregnancy were collected prospectively when smoking was less stigmatizing and preceded the release of the U.S. Surgeon General Report on health hazards of smoking in 1964 [66]. Analysis of a subsample of the NCPP cohort showed that the enrolled pregnant women accurately

reported their smoking status as validated against prenatal serum concentration of cotinine, a nicotine metabolite [67].

The racial diversity of our cohort extends findings from other life course studies of smoking which have primarily involved white, predominately European, populations. We were limited by our relatively small sample size to investigate possible interactions between SES and race/ethnicity and changes in SES across the lifecourse [68-70]. Some studies have found that changes or accumulation of socioeconomic circumstances, in addition to the main effect of adult or childhood SES, may contribute to adult health outcomes [7, 14, 71].

We were more successful in follow-up tracing of NCPP participants from higher childhood SES, but due to over-sampling of low SES groups in the original NCPP, the follow-up cohort had sufficient SES variation. Study estimates may have been affected if participation was also dependent on smoking status. However, our cohort is young enough not to be significantly affected by differential tracing and participation due to smoking-related morbidity and mortality.

Conclusions

Our findings suggest that women's smoking status in middle adult life is influenced by a myriad of socioeconomic factors including those encountered in earlier life periods. Low childhood and adult SES are similarly associated with increased risk of current smoking, pointing to the fundamental role of socioeconomic circumstances in forming lifelong smoking habits. Socioeconomic differences between smokers who quit and current smokers are similar to those found between lifetime nonsmokers and current smokers, suggesting that both socioeconomic differences in smoking initiation and cessation contribute to the increased risk of persistent smoking among women of low SES. In addition, exposures to prenatal tobacco smoke as well as household tobacco smoke in adult life have strong and enduring influences on women's smoking behavior.

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Table 1

Univariable associations of adult smoking status with lifecourse socioeconomic circumstances and passive tobacco exposure ($n = 262$)

	Current smokers $n = 69$		Former smokers $n = 70$		Never smokers $n = 123$		Current vs. never smokers		Former vs. never smokers		Current vs. former smokers	
	n	% or SD ^a	n	% or mean	n	% or mean	OR ^b	95% CI ^c	OR	95% CI	OR	95% CI
Age at follow-up (year)	41.6	1.9	41.7	1.6	42.0	1.8	0.9	0.7–1.0	0.9	0.8–1.1	1.0	0.8–1.2
Race/ethnicity												
White	18	26	26	37	25	20	1.0	1.0	1.0	1.0	1.0	1.0
Hispanic	30	44	25	36	44	36	0.9	0.4–2.0	0.5	0.3–1.1	1.7	0.8–3.9
African American	21	30	19	27	54	44	0.5	0.2–1.2	0.3	0.2–0.7	1.6	0.7–3.8
Mother's birthplace												
US	43	63	46	66	72	59	1.0	1.0	1.0	1.0	1.0	1.0
Foreign	25	37	24	34	51	41	0.8	0.4–1.5	0.7	0.4–1.4	1.1	0.6–2.2
Childhood												
Maternal education at birth												
>HS	8	12	8	11	14	12	1.0	1.0	1.0	1.0	1.0	1.0
HS	29	43	32	46	49	40	1.0	0.4–2.8	1.1	0.4–3.0	0.9	0.3–2.7
<HS	30	45	30	43	58	48	0.9	0.3–2.4	0.9	0.3–2.4	1.0	0.3–3.0
Family per-capita income at birth												
Highest (\$1,751–6,000)	20	32	16	24	41	34	1.0	1.0	1.0	1.0	1.0	1.0
Medium (\$1,151–1,750)	22	36	27	41	43	36	1.0	0.5–2.2	1.6	0.8–3.4	0.7	0.3–1.5
Lowest (\$0–1,150)	20	32	23	35	36	30	1.1	0.5–2.4	1.6	0.8–3.6	0.7	0.3–1.7
Parental occupation												
White collar	17	26	35	50	43	35	1.0	1.0	1.0	1.0	1.0	1.0
Blue collar	49	74	35	50	79	65	1.6	0.8–3.1	0.5	0.3–1.0	2.9	1.4–5.9
Prenatal tobacco exposure												
No	26	39	41	59	90	74	1.0	1.0	1.0	1.0	1.0	1.0
Yes	41	61	29	41	31	26	4.6	2.4–8.7	2.1	1.1–3.8	2.2	1.1–4.4
Household ETS during childhood												
No	14	20	15	21	36	29	1.0	1.0	1.0	1.0	1.0	1.0
Yes	55	80	55	79	87	71	1.6	0.8–3.3	1.5	0.8–3.0	1.1	0.5–2.4
Adolescence and Early Adulthood												

	Current smokers <i>n</i> = 69		Former smokers <i>n</i> = 70		Never smokers <i>n</i> = 123		Current vs. never smokers		Former vs. never smokers		Current vs. former smokers	
	<i>n</i> or mean	% or SD ^a	<i>n</i> or mean	% or SD	<i>n</i> or mean	% or SD	OR ^b	95% CI ^c	OR	95% CI	OR	95% CI
Single parent at age 13												
No	41	59	55	79	90	73	1.0	1.0	1.0	1.0	1.0	1.0
Yes	28	41	15	21	33	27	1.9	1.0–3.5	0.7	0.4–1.5	2.5	1.2–5.3
Mother at age 21												
No	47	68	60	88	101	82	1.0	1.0	1.0	1.0	1.0	1.0
Yes	22	32	8	12	22	18	2.1	1.1–4.3	0.6	0.3–1.5	3.5	1.4–8.6
Education												
College graduate	19	27	30	43	64	52	1.0	1.0	1.0	1.0	1.0	1.0
Tech/some college	33	48	34	48	40	33	2.8	1.4–5.5	1.8	1.0–3.4	1.5	0.7–3.2
High school	17	25	6	9	19	15	3.0	1.3–6.9	0.7	0.2–1.9	4.5	1.5–13.4
Mid-adulthood												
Income												
Highest (90,000)	10	15	28	41	44	37	1.0	1.0	1.0	1.0	1.0	1.0
Medium (50,000– <90,000)	21	31	21	30	40	33	2.3	1.0–5.5	0.8	0.4–1.7	2.8	1.1–7.2
Lowest (<50,000)	37	54	20	29	36	30	4.5	2.0–10.3	0.9	0.4–1.8	5.2	2.1–12.8
Occupation												
White collar	33	52	40	59	77	65	1.0	1.0	1.0	1.0	1.0	1.0
Blue collar	31	48	28	41	41	35	1.8	0.9–3.3	1.3	0.7–2.4	1.3	0.7–2.7
Currently a single mother												
No	47	68	56	80	103	84	1.0	1.0	1.0	1.0	1.0	1.0
Yes	22	32	14	20	20	16	2.4	1.2–4.8	1.3	0.6–2.7	1.9	0.9–4.1
Household ETS in adulthood												
No	20	29	28	40	72	59	1.0	1.0	1.0	1.0	1.0	1.0
Yes	49	71	42	60	49	41	3.6	1.9–6.8	2.2	1.2–4.0	1.6	0.8–3.3

^aStandard deviation^bOdds ratio^cConfidence interval

Table 2
Multivariable associations of adult smoking status with life course socioeconomic conditions and passive tobacco exposures

[illegible]

	Model 1			Model 2			Model 3		
	Current vs. never smokers	OR ^a	95% CI ^b	Former vs. never smokers	OR	95% CI	Current vs. former smokers	OR	95% CI
Lowest (<50,000)									
Currently a single mother									
No									
Yes									
Household ETS in adulthood									
No									
Yes									

Note: Model 1 includes race/ethnicity, prenatal tobacco exposure and parental occupation; Model 2 includes Model 1 variables + education, single parent household at age 13 and early motherhood; Model 3 includes Model 2 variables + current income, single motherhood and adult ETS

^aOdds ratio

^bConfidence interval