The Persistence of Educational Disparities in Smoking

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Besides reducing overall smoking prevalence, do anti-tobacco policies to raise prices and restrict locations for smoking also reduce educational disparities? Theories emphasizing proximate disincentives answers yes, suggesting that the policy changes create stronger disincentives for smoking among low education groups. A social resource or fundamental cause theory suggests in contrast that flexible and broad resource advantages of high education groups maintain inequalities in health behavior despite policy changes. Using 24 National Health Interview Surveys, this study tests these claims by describing smoking prevalence by education level from 1976 to 2006 in the United States and giving special attention to the last ten years when tax and clean-air policies have expanded. Logistic regression models that allow trends in smoking to vary by education, race, ethnicity, and nativity find a small decline in educational disparities in smoking. However, this decline stemmed from trends among Hispanic and foreign-born respondents; in contrast, smoking disparities among white, African American, and native-born respondents show no evidence of narrowing. Likely due to the greater resources of high education groups for health behavior, changes in prices and restrictions thus far have done little to reduce educational disparities. Keywords: smoking trends, tobacco use, education, smoking policies, disparities.

Although smoking increases the risk of premature mortality among all users (DHHS 2004; Peto et al. 1994), the problem of tobacco use has special relevance to low socioeconomic status (SES) groups (Barbeau, Krieger, and Soobader 2004). For example, figures for 2006 show that 35.4 percent of Americans with 9 to 11 years of education smoke compared to 9.6 percent with an undergraduate degree—a ratio of 3.7 to 1 (Rock et al. 2007). Given its well-known link with premature death, this large disparity in smoking contributes substantially—likely somewhere between 25 to 50 percent—to SES disparities in mortality (Jha et al. 2006; Marmot 2006). Because of the differential, efforts to reduce smoking further need to focus on low SES groups, those who have been most resistant to change (Fagan et al. 2004). The National Institute of Health (NIH) (2007) not surprisingly gives prominent attention to tobacco use in its plans to reduce health disparities.

SES disparities in smoking have become a serious problem only in the last several decades. Historically, high SES groups adopted smoking early in the twentieth century and adoption by others followed (Ferrence 1989), but the growing publicity of the harm of cigarettes in the 1960s led to a shift in SES patterns (DHHS 2000:347; Pampel 2005). In the 1970s and 80s, smoking fell faster among high SES groups and widened SES disparities considerably (Escobedo and Peddicord 1996; Fiori et al. 1989; Pierce et al. 1989).

In recent years, however, policy changes involving taxes on cigarettes and workplace restrictions may have begun to reverse the trend of widening SES differences. Although the policies are aimed primarily to lower smoking overall, advocates expect them to also to lessen disparities. An implicit theory suggests that by raising the proximate disincentives for smoking most among low SES groups, the policies will moderate smoking disparities. However,
another theory suggests that the continuing resource advantages of high SES groups outweigh the importance of policy changes and maintain disparities in smoking.

This study aims to evaluate the impact of policy changes on disparities in smoking and these two theories via the straightforward but thus far unused method of describing the trends through the most recent period available. If disparities have declined with the growth of price increases and clean air laws, it would support the proximate disincentive theory and the potency of recent policies. If disparities have not declined with policy changes, it would support the resource-based theory and more pessimistic conclusions about policy efficacy for low SES groups.

The results of such a test have implications that go beyond one addictive habit. They can more broadly shed light on the tendency for disadvantaged groups, who already lack access to health care, nutritious food, and safe living conditions, to exacerbate resulting health problems with unhealthy behaviors, and for advantaged groups to maintain greater health returns through use of economic, social, and cultural resources. Tests of the theories with regard to tobacco can say much about health inequalities more generally.

In examining trends in disparities, the analysis follows previous studies (Escobedo and Peddicord 1996; Giskes et al. 2005; Pierce et al. 1989) in using education as a key component of SES. Education remains largely stable during adulthood and serves as a proxy for permanent income and wealth (Adda and Cornaglia 2006). It also creates human capital, problem-solving skills, and social ties that aid tobacco avoidance and cessation (Cowell 2006; Mirowsky and Ross 2003). Education therefore has stronger effects than other SES components (Barbeau et al. 2004; Huisman, Kunst, and Mackenbach 2005) and, for over-time comparisons of several decades, has advantages in its comparability. However, some of the arguments make explicit references to income and costs, making it valuable to secondarily examine changes in income disparities in smoking.

Along with education, the analysis must consider varied trends by race and ethnicity. In particular, trends among Hispanics and those born outside the United States may differ from other groups due to low levels of both education and smoking (Osypuk et al. 2006). Immigrants and foreign-born residents, particularly from Latin American countries, tend to have low smoking rates (Wilkinson et al. 2005), likely because of the earlier stage of the tobacco epidemic in their countries of origin, the selection of healthy immigrants, and anti-smoking socialization by the families of immigrants (Acevedo-Garcia et al. 2005). As a growing portion of the less educated adult population (U.S. Census Bureau 2008), Hispanics and immigrants may depress smoking rates and educational disparities in the United States.

Theories

According to common views, two major policy changes in recent years should moderate SES disparities in smoking. First, largely due to higher state excise taxes, cigarette prices have risen by 134 percent from December 1997 to April 2008 (Bureau of Labor Statistics 2008) and, by several accounts, higher prices have stronger negative effects on smoking among low income groups (Farrelly and Bray 1998; Townsend 1987; Warner 2000). In purely monetary terms, the price elasticity for smoking is greater for low income groups because higher prices impose a greater relative financial penalty (Hersch 2000). In addition to its indirect influence via income, education has a more direct influence. Following the rational addiction model (Becker and Murphy 1988), Gary S. Becker, Michael Grossman, and Kevin M. Murphy (1994) argue that the highly educated are more future oriented in making smoking decisions because they have more permanent income to gain from a longer life. Given their future health orientation, those with higher education are influenced little in either way by prices. In contrast, less educated persons more heavily discount the future and make smoking decisions based more on current cigarette prices (Chaloupka 1991).
Consistent with these arguments, David T. Levy, Elizabeth A. Mumford, and Christine Compton (2006) conclude the following from a study of women from 1992 to 2002 using the Tobacco Use Supplement of the Current Population Survey: “Smoking among low education women declined at a greater rate over the study period than among more highly educated women, in contrast with trends of earlier periods. Low education women were found to be particularly responsive to media messages as well as price, especially in comparison to high education women” (p. ii20). Similarly, S. Thomas and associates (2008) conclude from a comprehensive review that “the balance of econometric evidence suggests that increasing the price of tobacco is more effective in reducing smoking in lower-income adults and those in manual occupations” (p. 234).

Second, establishment of statewide clean-air laws—covering seven states and 24 percent of the population as of early 2005 (Bauer et al. 2005)—may most help disadvantaged workers (Farrelly, Evans, and Sfekas 1999). Low educated, blue-collar workers in factories and plants are less often covered by private smoke-free workplace policies (Moskowitz, Lin, and Hudes 2000) and less often helped by workplace health-promotion policies (Sorenson et al. 2004). The recent spread of state mandated workplace bans may therefore help low educated workers—those least often covered by private bans—more than high educated workers. State and local smoking bans in bars and restaurants, implemented to protect patrons from secondhand smoking, also discourage smoking of bartenders, servers, and other typically less educated beverage and food-service workers. Given the effectiveness of smoke-free workplaces in tobacco reduction (Ong and Glantz 2005), the spread of state mandates may most help workers with low education and high prevalence.

In addition to highlighting the costs of finding a place and time to light up, arguments about clean-air laws make another point. They suggest that the laws increase social support for tobacco avoidance among groups that otherwise have not yet responded to information on the benefits of smoking avoidance and have less private social capital to help quit (Sorensen et al. 2004). Increased social unacceptability of smoking that is associated with smoking bans leads to lower smoking in general (Alamar and Glantz 2006) but may most affect low educated smokers with the highest prevalence and the weakest anti-smoking norms (Gilpin, Lee, and Pierce 2004).

Arguments about the impact of these policy changes reflect an underlying theory of disparities in health behavior that focuses on equalizing the proximate disincentives for smoking between less and more advantaged groups. The underlying theory suggests that the decision to smoke involves weighing costs and benefits and that the relative costs generally prove greater among more advantaged groups. Raising costs to buy cigarettes, find a place to smoke, and deal with public anti-smoking sentiment most affects disadvantaged groups with fewer pre-policy proximate disincentives and reduces smoking disparities. Although policies reduce smoking for all education groups, they should do so more among those with less education.

An alternative social resource or fundamental cause theory suggests instead that other forces limit the potential for equalizing disparities. It argues that, particularly during recent decades of rising social and economic inequality in the United States (Goesling 2007), the greater resources and stronger anti-smoking motives of advantaged groups greatly outweigh the importance of proximate disincentives such as cigarette prices and location restrictions. These resources and motivations take several forms in helping to avoid pressures to smoke and overcome nicotine addiction. For example, high SES groups have more financial resources than others to use for counseling, nicotine replacement therapy, and prescription drugs (Giskes et al. 2005; Honjo et al. 2006); more to gain in longevity from avoiding smoking (Lawlor et al. 2003); and less stress for which smoking may serve as a coping device (Wilkinson 1996). In addition, education represents a critical resource in another way: The learning, accomplishment, and development of problem-solving skills that come from advanced schooling contribute to learned effectiveness and personal skills that help in avoiding pressures to smoke and devising solutions to nicotine addiction (Mirowsky and Ross 2003). As a result, persons...
from all education backgrounds express similar desires to quit, but high education groups are more successful in reaching their goals (DHHS 2000:353; Honjo et al. 2006). Higher prices and restrictions on places to smoke may lower smoking prevalence overall but, absent structural change in inequality, fail to overcome the advantages of high education groups.

Given the varied resource differences, group-based identities and cultural norms may emerge that reinforce SES smoking disparities. Just as teens often use smoking as a source of identity and image that both solidifies ties to friends who smoke and defines separation from others who do not smoke (Johnson and Hoffmann 2000), smoking becomes a symbol among adults that, like other cultural tastes or fashions, distinguishes SES-based lifestyles (Cockerham 2000; Pampel 2006). As a result, the friendship, neighborhood, and acquaintance networks (i.e., social capital) of high SES groups offer more support, encouragement, and approval for quitting than others (Brown et al. 2006; Chen, White, and Pandina 2001). Social resources that reinforce individual resources of high SES groups can limit the impact of policy changes on disparities.

Such expectations follow from a perspective treating SES as a fundamental cause of disease (Link 2008; Link and Phelan 1995). The perspective argues broadly that a strong relationship between health and social position persists despite changes in public health policies and the near elimination of many disease agents. As public health programs eradicate one set of risks factors for disadvantaged groups (e.g., unsanitary water supplies, low immunization), others quickly replace them (e.g., exposure to pollution, workplace injuries). More recently, as new information and medical interventions such as Pap smears and mammograms developed to improve health, high education groups more readily used them (Link et al. 1998). Similarly, high education groups better follow complex treatment regimes developed for diabetes and HIV (Goldman and Smith 2002; Lutfey and Freese 2005). Applied to tobacco, the fundamental cause argument would note that disparities did not widen greatly until after the government began in the mid-1960s to widely publicize evidence about the dangers of smoking (Link 2008). High education groups took advantage of the new health information more quickly, had the resources to resist the attractions of nicotine, and contributed most to declining prevalence rates. More recent policy changes involving higher prices and smoking restrictions further convey messages of the risks of tobacco that highly educated groups respond to readily. Even when they moderate disparities in incentives and reduce smoking prevalence overall, policies may do little to change disparities in behavior.

Of course, disparities in smoking may eventually disappear with the diffusion of anti-smoking norms across the population. When smoking among high education groups approaches zero, any further reductions by definition will narrow disparities. With 2006 prevalence levels at 20.8 percent (Rock et al. 2007), however, room remains for the highly educated to respond to new policies with lower smoking and for disparities to persist. A study of smoking in 2002 and 2006 among New York City residents illustrates this result (Ellis et al. 2007). In April and July 2002, respectively, the state increased its cigarette excise tax by $.39 and the city increased its cigarette excise tax by $1.42, making the combined state/city tax the highest in the country. In 2003, the city implemented a comprehensive workplace ban on smoking that included restaurants and bars. Although the reported figures show a clear decline in smoking overall, they also show a larger decline among more educated groups. Over the four years, smoking of those with less than a high school degree dropped by 1.5 percentage points or 6.1 percent, while smoking of those with a college degree dropped by 3.4 percentage points or 20.7 percent. The ratio of smoking for the least educated to the most educated group rose from 1.49 to 1.76. Similarly, a study of 18 European countries finds that low educated smokers benefitted no more than high educated smokers from tobacco control policies (Schaap et al. 2008).

1. Should disparities in smoking eventually disappear, the fundamental cause perspective argues that other causes of health disparities will increase in importance.
Predictions of the limited influence of proximate policies on disparities in health behavior relate to a long tradition in social epidemiology that emphasizes the importance of inequality and “upstream” causes of poor health (McKinlay 1975; Schnitker and McLeod 2005; Wilkinson 1996). Applying this perspective to smoking suggests some pessimism about the ability of policies to sufficiently change disincentives to overcome other forces of inequality without substantial improvements in the circumstances of disadvantaged groups (Graham et al. 2006).

Empirical Approach

The proximate incentives theory and the social resources theory offer competing predictions. Given remarkable increases in at least the last decade in cigarette taxes and clean-air laws that most penalize low SES smokers, the proximate incentives theory predicts declining disparities. The social resources or fundamental cause theory argues instead that advantages of high SES groups trump proximate incentives in influencing smoking prevalence and predicts that disparities will change little or widen despite changing prices and laws. To test the predictions about changes in disparities in smoking, this study compares trends in cigarette use by level of education (and, secondarily, income) for persons ages 25 to 64 and for subgroups defined by race, ethnicity, and nativity. Rather than demonstrate the existence of educational disparities in tobacco use, it aims to determine if, given increasing prices and restrictions on smoking over the last decade, educational differences have reversed past trends by declining. It does so using nationally representative data from the National Health Interview Survey (NHIS) for 1976 to 2006 and appropriate controls for changes in the demographic composition of the population.

Despite changes in policies and competing views about their efficacy, studies have rarely examined recent trends in education or income differences in smoking. Early studies demonstrated increasing disparities in previous decades (Escobedo and Peddicord 1996; Pierce et al. 1989) but have not been extended through the 2000s. The recent study of Levy and associates (2006) examines educational disparities for women in the 1990s but not for men or for earlier and later years. One exception, Peter Franks and associates (2007) compare the effects of prices on smoking by income group, finding little recent change in disparities, but Matthew C. Farrelly and Mark Engelen (2008) dispute these findings. Another exception, J. A. Ellis and associates (2007) find increasing disparities, but the results are limited to four years and New York City.

Further study of both long- and short-term changes can help evaluate the underlying theories of health inequality. Evidence of narrowing disparities in recent years would suggest that tobacco reduction policies have helped meet the special needs of low education groups and support arguments about the equalizing impact of changes in the proximate disincentives to smoke. In contrast, evidence of persistent disparities in smoking would emphasize the need to better target anti-tobacco policies and support arguments about the enduring and dominant influence of education resources for health behaviors.

The focus here on the overtime correspondence between disparities and policies complements common approaches used to study the effects of policies on smoking. Studies often compare smoking across states with different taxes and laws (e.g., Farrelly and Engelen 2008; Franks et al. 2007). However, such approaches must deal with problems of heterogeneity: Unmeasured traits such as anti-smoking norms may overlap with strong and weak state policies so as to confound the effects of policies on smoking (DeCicca et al. 2008). The study of national trends (controlling for demographic composition) averages experiences of diverse states but in essence compares the same unit (the U.S. population) at different times rather than different units (the 50 states). The time-series approach (used in New York City by Ellis et al. [2007]) also faces threats to validity, particularly from the spurious coincidence of trends.
However, it can at minimum establish if dramatic increases in cigarette prices and smoking restrictions coincide with changes in smoking disparities, a key requirement for the claims of the proximate-disincentive and policy-efficacy arguments.

Methods

Data

The NHIS is a continuous, multipurpose survey of the U.S. civilian noninstitutionalized population living in addressed dwellings. Among many other things, it has asked questions on smoking in 24 surveys over the 31 years from 1976 to 2006 (National Center for Health Statistics 2008a). Briefly, the surveys use a multistage probability sampling design to select representative samples of households and interview members of the sampled households. Household response rates for the early core surveys reached at least 95 percent (Caban et al. 2005), but some of the supplemental surveys had lower rates (Escobedo and Peddicord 1996). For the years from 1997 to 2006, when the NHIS underwent a change in design, the household and sample adult interviews included smoking items as part of the core questionnaire. Reflecting a trend of lower response in all national surveys, rates have fallen for the NHIS to 70 to 80 percent since 1997 (Caban et al. 2005). In 2004, for example, 86.5 percent of eligible families participated in the surveys (National Center for Health Statistics 2008b). Those ages 25 to 64 are selected for the analysis. By age 25, nearly all eventual smokers will have started, and most of those obtaining a high school or college degree will have already done so. Excluding those age 65 and over minimizes the influence of differential mortality on educational comparisons.

The stratified cluster sampling design requires statistical adjustments for overlap among respondents from the same primary sampling unit, and changes in the sample designs require different adjustments for 1976 to 1983, 1985, 1986 to 1994, 1995, 1997 to 2005, and 2006 (National Center for Health Statistics 2008a). The svy commands in Stata 9.2 correct standard errors for the deviations from simple random sampling with Taylor series linearization (Stata 2005). In addition, use of the data requires weighting for oversampling of African Americans, Hispanics (since 1995), and Asian Americans (since 2006). Weights given by the NHIS adjust for the size of the race and ethnic groups as well as for nonresponse and stratification. The NHIS weights are then also adjusted so that each year counts equally. After eliminating missing data on the key variables and selecting respondents ages 25 to 64, cases are weighted to create an identical sample size for each year (n = 19,667.9) that equals the total sample size for all years (N = 472,030) divided by the number of years (24).

Measures

Excepting some change in the treatment of irregular smokers, the surveys are consistent in basic questions on tobacco use. Ever smokers are defined as persons who report smoking at least 100 cigarettes in their lifetime. Among ever smokers, current smokers are then distinguished by their answer to the question, “Do you smoke now?” Many surveys also contain retrospective information on age of initiation and periods of cessation, but the analysis focuses on the more easily obtained and accurate self reports of current and former smoking (Patrick et al. 1994).

Education is measured as years of school completed, but changes in the exact categories used by the NHIS suggest the creation of a small set of consistent groups that reflect the important milestones of high school and college graduation. Respondents are thus classified

2. The change in design appears to have little if any influence on the results. Footnote 5 discusses the issue in the context of modeling trends in smoking.
into four categories: 0 to 11 years (no high school degree), 12 years (high school graduation), 13 to 15 years (some college), and 16 and more years (college graduation). Beginning in 1997, a coding scheme added new categories for those obtaining GEDs (treated as completing 12 years of schooling) and getting vocational or technical degrees (treated as having some college). Compared to earlier years, the changes decrease the percentages of high school dropouts and graduates and increase the percentages with some college. Income is less comparably measured than education across the full time period, with categories, upper bounds, and extent of missing data varying across years. For select years, however, a four-category measure of family income in real dollars that divides the sample in near quartiles (under $18,000, $18,000 to $40,999, $41,000 to $70,999, and $80,000 and more) supplements the results for education.

Along with age and sex, the main sociodemographic variable is race/ethnicity. This variable distinguishes four categories: self-identified non-Hispanic whites, non-Hispanic African Americans, non-Hispanic others, and Hispanics (for short, whites, African Americans, others, and Hispanics). The small size and disparate membership of the other category (consisting of only 3.6 percent of the sample and combining Asian Americans, Pacific Islanders, Native Americans, and others) make it less meaningful than the others. Respondents in this category will be included in the combined analyses but not used in the separate group analysis.

The NHIS has questions on foreign birth and years lived in the United States beginning in 1990. A simple measure distinguishes those born in and outside the United States. With the missing years, most analyses exclude this variable but separate analyses for the shorter time period compare trends by education for native- and foreign-born respondents.

Analysis

Logistic regression models describe the trends in current smoking across the four education categories with controls for changing age, sex, race, and ethnic composition of the population. First, a quadratic time trend describes nonlinear changes in smoking. The trend in smoking should be downward and the coefficient for the linear time variable should be negative. However, to the extent that the rate of decline has slowed, a positive coefficient for a squared time variable should moderate the downward trend in more recent years. Second, coefficients for education dummy variables (with the highest group, college graduates, omitted) reflect disparities. The higher smoking of less educated groups will show in positive coefficients for dummy variables. These education effects are adjusted for controls of age and age squared (to reflect the rise and fall of smoking with age) and dummy variables for race and ethnicity. Third, and most importantly, the year and year squared terms interact with education to describe the education-specific trends. This allows the nonlinear trends in smoking to differ by education group. The coefficients for the interaction terms show differences in the effects of year and year squared for the education groups but make for difficult interpretation.

To aid in interpretations, the interaction model coefficients can be used to obtain predicted probabilities for each year and education group. The predicted probabilities come from (1) substituting values for year and education (with means assigned to control variables such as age and gender), (2) computing predicted logits, and (3) transforming the logits into predicted probabilities. Then graphing the predicted probabilities of smoking for each year by each education group presents the results visually. If the trends for education groups converge, it shows declining disparities as predicted by the proximate disincentives hypothesis; if the trends diverge or remain parallel, it shows rising or constant disparities as predicted by the social resources hypothesis.

3. Footnote 5 describes checks for the possibility that the slightly changed measure of education biases measurement of the trend in disparities.

4. Allison (1999) points out that varying residual variation or unobserved heterogeneity across groups can make interaction coefficients in logistic regression invalid. This problem might affect comparisons of trends across education
Results

Based on results in Table 1, the percentage current smokers in all four education groups declines over time but does so more for the college educated. Over the period from 1976/1980 to 2001/2006, smoking of those without a high school degree falls by 13 percentage points from 47 percent to 34 percent, while smoking of those with a college degree falls by 17 percentage points from 28 percent to 11 percent. As a result, the difference between the two groups increases. However, the trends differ between the first and last half of the time period. The gap between the two education groups of 19 percentage points in 1976/1980 rises to 27 percentage points in 1991/1995 and then falls to 23 percentage points in 2001/2006. As illustrated by the last column of Table 1, which presents the change during the last half of the period, smoking among the college educated drops more slowly than those without a high school degree.

Logistic regressions for current smokers versus nonsmokers (including both former and never smokers) reveal more precisely how the trends in smoking vary by education group. In Table 2, columns 1 and 2 first demonstrate a curvilinear trend in smoking. The negative logit coefficient for year of –0.031 and odds ratio of .969 show a general decline over time in smoking, but the positive coefficient for year squared of .027 and odds ratio of 1.027 show that the rate of decline levels off in recent years. The results also show strong effects of education. The odds of smoking for those without a high school degree are 3.677 times higher than for the omitted group of college graduates. The odds for high school grads and those with some college are, respectively, 2.863 and 2.217 times higher.

The multiplicative interaction terms in columns 3 and 4 next show that the nonlinear effects of year and year squared vary by educated group. The interaction terms for year are positive for all three education groups and weaken the otherwise negative coefficient for year; the interaction coefficients for year squared are negative for all three education groups and weaken the otherwise positive coefficient for year squared. In other words, coefficients for the interaction terms produce smaller negative year effects and smaller positive year squared effects for the three lower education groups. This implies that, compared to the trend for college graduates, the trends for less educated groups show smaller declines but less leveling off.

Controls for age, gender, race, and ethnicity are added to the logistic regression model in columns 5 and 6 of Table 2 (in essence standardizing the trends by age and demographic composition). The positive age and negative age squared coefficients reflect the rise and fall of smoking with age, and the other coefficients and odds ratios indicate lower smoking of groups or, equivalently, comparisons of education effects across time. That OLS estimates not subject to the same problem give near equivalent results to the logistic regressions suggests the problem does not distort the results presented here. Still, Williams (2008) suggests using heterogeneous choice models to correct for the problem of unequal residual variation. Using a linear year term as a determinant of the residual variation and the oglm STATA program written by Williams, the results do not change greatly. Although residual variation varies by year, the predicted probabilities by education and year obtained from the heterogeneous choice model differ little from those obtained from logistic regression. Since Keele and Park (2006:1) warn that “the estimates in heterogeneous choice models tend to be biased in all but ideal conditions and can often lead to incorrect inferences,” the tables and figures present the logistic regression results.

5. Additional analyses test for the possible influence on the trend of the changes in design and measurement of education that the NHIS implemented in 1997. A dummy variable equal to one for 1997 and after, and two product terms of the dummy variable times year and year squared were added to the first equation in Table 1. If the change in design affects the results, these added terms should influence smoking. To the contrary, all three terms are insignificant and give little indication of disruption in the smoking trends since 1997.

6. Perhaps changes in the meaning of education affect the results. The percentage with less than 12 years of school fell from 30.4 in 1976 to 11.6 in 2006; conversely, the percentage of college graduates rose from 16.6 in 1976 to 29.3 in 2006. The smaller numbers and more disadvantaged position of high school dropouts in 2006 than in 1976 might make them particularly prone to smoke and affect over-time comparisons. At the same time, however, educational changes make college graduates a less selective group, thus affecting over-time comparisons in the other direction. Models using varying categories of education across time (e.g., combining years of school of 10–11 with 12 and 14–15 with 16 in early years but not in late years) reduce the gap in smoking between high and low educational levels but the pattern of change remains much as for the absolute measure of education.
women compared to men and lower smoking of African Americans, Hispanics, and others compared to whites. With these controls, the levels of smoking among less educated groups increase relative to the college educated: The odds ratio for high school dropouts relative to college graduates rises from 3.68 to 4.77. With controls, the odds ratios for smoking of high school graduates and those with some college rise to 3.12 and 2.31. These figures highlight the substantial decline in smoking with higher education.

The last columns add the interaction terms of year by education, demonstrating that the net trends, like the gross trends, vary by education group. To help interpret the meaning of the coefficients in the last model, Figure 1a plots the observed proportions of current smokers and

| Table 1 • Percentage Current Smokers by Education Group and Year, Pooled NHIS Respondents, 1976–2006 |
|---------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|------------------|
| Percentage current smokers      | b           | Z           | b           | Z           | b           | Z           | b           |
| 0/11                            | .031*       | .969        | .074*       | .929        | .033*       | .968        | .075*       |
| 12                              | .027*       | 1.027       | .094*       | 1.099       | .045*       | 1.046       | .109*       |
| 13/15                           | 1.302*      | 3.677       | .685*       | 1.984       | 1.562*      | 4.768       | .930*       |
| 16+                             | .069*       | 1.071       | .143*       | .867        | .133*       | .875        |
| N = 472,030                     |             |             |             |             |             |             |                |

*Column focuses on the last half of the full period when gap shifts from rising to falling.

<p>| Table 2 • Logistic Regression Coefficients and Z-Ratios for Models of Current Smoking, Pooled NHIS Respondents, 1976–2006 |</p>
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N = 472,030

*976 = 1, 1977 = 2, . . . , 2006 = 31
*p < .01 (two-tailed tests)
predicted probabilities based on the interaction model for each year and education group (with controls for age, gender, race, and ethnicity). In Figure 1a, the curve for those without a high school degree shows a steady decline, while the curve for those with a college degree shows a decline that levels off in later years. The two trends produce some convergence. However, the
curves for those with high school degrees and with some college show smaller declines than the other two groups. The difference in the curves for the lowest and highest educated groups rises to a peak of 26.6 percentage points in 1994 and then falls to 23.8 percentage points in 2006—a decline of 2.8 percentage points. However, the gaps for the other two groups rise over the full time span. For example, the difference in the curves between high school graduates and college graduates begins in 1976 at a minimum value of 11.7 percentage points and rises to a maximum of 20.7 percentage points in 2006.

Trends in educational disparities within most race and ethnic groups demonstrate less narrowing. Based on models estimated separately for whites, Figure 1b reveals that smoking of those with less than a high school degree has changed little, and the gap with college graduates widened considerably over the full period. The gaps also increase between college graduates and both high school graduates and those with some college. For African Americans, small educational differences in smoking early on have widened by the end of the period (Figure 1c). For whites and African Americans, the higher resources of more educated groups may explain the faster drop in early periods. There may also be a floor effect that influences the trajectory of the highest educated in more recent periods, but the gap is still maintained or increased.

In contrast to whites and African Americans, smoking of Hispanics converges across educational levels (Figure 1d). Results by nativity—over the shorter period from 1990 to 2006 for which the measure of U.S. birth is available—help account for differences by race and ethnicity. Figure 1e plots trends in smoking by education for native-born respondents and Figure 1f does the same for foreign-born respondents. The graphs demonstrate little change among the native born (94.0 percent of whom are white or black) but reveal clear convergence in educational differences among the foreign born (68.4 percent of whom are Hispanic or other race).

These graphs suggest that without the influx of less educated and low smoking immigrants, educational disparities would have widened or changed little. This can be seen when computing the gap between the education curves in Figures 1a through 1f (or the gap in the predicted probabilities of smoking by education). For the full sample, the gap in predicted smoking for low and high educated groups falls by 2.8 percentage points from 1994 to 2006. However, the predicted gap in smoking rises by 4.6 percentage points among whites and by 2.6 percentage points among African Americans. For Hispanics, the gap falls by 6.4 percentage points. Still further, the gap increases by 3.4 percentage points for the native born and falls by 4.0 percentage points for the foreign born. Like the figures, these numbers indicate that education disparities for the full sample would have risen if not for the divergent patterns among Hispanics and foreign-born respondents.

Perhaps disparities have declined more for income groups than education groups. To check on this possibility, some additional runs compare smoking disparities across four income categories for the two years—1994 and 2006—that bound the period of declining disparities. The results show that income has considerably smaller influence on smoking than education. The likelihood ratio from a logistic regression on smoking increases by 38 percent when adding education dummies to an equation with income and by 10 percent when adding income dummies to an equation with education. More importantly, the interactions of income group and year show that disparities across income groups change little over time but, like education, the trends vary by ethnicity. Among whites, the odds of smoking for the highest income group dropped by 16 percent, while the odds for the lowest income groups dropped by less than 1 percent. Among

7. Calculation of confidence intervals shows that the predicted smoking of each education group in 2006 remains statistically distinct from the others.
8. When run separately for white males and females, the results are similar enough to combine the genders in one graph. The same holds for graphs of other race and ethnic groups.
9. Given the small number of Hispanics in early NHIS surveys, the figures examine the period beginning in 1987, when the number of Hispanic respondents reaches 1,900.
10. The education gap for the other race/ethnic category also falls by 2.3 percentage points.
Hispanics, the odds of smoking for the highest income group dropped by 2 percent, while the odds for the lowest income group dropped by 26 percent. For income as well as education, then, whites show divergence in trends and Hispanics show convergence in trends.

A few simple correlations can help link the trends in smoking disparities to tobacco price changes and clean-air laws. For the years from 1990 to 2006, the difference in smoking prevalence between the lowest and highest education groups (smoking disparity for short) has correlations of $-0.842$ with cigarette prices in real dollars and $-0.645$ with the cumulative number of local tobacco control ordinances. The negative relationship suggests that as prices and restrictions rise, the smoking disparity declines. However, because price is also highly correlated with the percentage of the population that is foreign born ($r = 0.890$), the strong and negative correlation of prices with the disparity may actually capture the growing portion of low-smoking, foreign-born persons in the low educated population. Indeed, the percentage of low-educated respondents who are foreign born increases from 20.2 percent in 1990 to 41.9 percent in 2006.

One way to control for changes in the composition of the population is to examine the correlations of price and clean-air laws with the smoking disparity for native-born respondents. These correlations of 0.502 and 0.784 are positive rather than negative, meaning that the disparity has grown at the same time prices have risen and clean-air laws have become more common. Among native-born respondents, then, high education groups have most reduced their smoking during a period of increasing cigarette prices and clean-air laws. Further, the correlation of prices and clean-air laws with the smoking disparity between high school graduates (who have increased less in terms of foreign-born composition) and college graduates are likewise positive. This again suggests that the less educated foreign-born population rather than the majority native-born population is responsible for small recent declines in smoking disparities between the least and the most educated.

### Discussion

Theories of proximate disincentives and social resources offer competing predictions about changes in SES disparities in tobacco use over the past several decades. The former theory predicts that the greater disincentives of higher cigarette prices and clean-air laws for smoking among low than high SES groups will reduce smoking most among low SES groups and reduce disparities. The latter theory, an extension of arguments presented by the fundamental cause theory of the relationship between SES and health (Link and Phelan 1995), predicts that, absent changes in structural equality, the greater resources and stronger anti-smoking motives of high SES groups give them advantages that greatly outweigh the importance of proximate disincentives such as cigarette prices and location restrictions. Although SES disparities are not immutable (indeed, high SES groups once smoked more than low SES groups and disparities will disappear as prevalence approaches zero), the resources of high SES groups in recent decades should maintain disparities despite policy changes.


12. Estimates with correction for a first-order autoregressive process in the residuals using Prais-Winsten generalized least squares confirm these results. The differenting approach of the method isolates yearly increases and decreases in smoking prevalence, prices, and clean-air laws from the general trend and does more to match changes in policy with changes in smoking. Like the correlations, these estimates show that prices and clean-air laws are significantly and negatively associated with smoking disparities overall but positively associated with disparities among native-born respondents.

13. Like the correlations, the first-order autoregressive estimates show positive or insignificant effects of prices and clean-air laws on smoking disparities for native-born groups.
Analysis of data from the NHIS reveal limited progress in reducing educational disparities in smoking and support the predictions following from social resource arguments. From 1994 to 2006, those without high school degrees have lowered smoking slightly more than those with college degrees, while those with high school degrees and some college have lowered their smoking slightly less than the college educated. However, the change among the lowest educated group appears to stem from Hispanic and foreign-born respondents. White, African American, and native-born individuals without high school degrees show little decline in smoking and do not contribute to declining disparities with college graduates. With the exception of Hispanics and foreign-born groups, educational disparities have continued to widen or remained stable. The results largely demonstrate enduring disparities.

The decline in smoking among low-educated Hispanics and foreign-born residents—a key source of the decline for those without a high school degree—likely reflects the impact of immigration on educational disparities. Among Hispanics without a high school degree, 17.3 percent of the foreign born smoked compared to 33.7 percent of the native born. These results match other studies that find lower smoking among immigrants (Acevedo-Garcia et al. 2005; Wilkinson et al. 2005). A rise in the Hispanic population from 6.8 percent of the sample in 1976 to 13.6 percent in 2006, and a rise of the foreign-born from 10.4 percent of the sample in 1990 to 16.5 percent in 2006, both contribute to the modest decline of educational disparities in smoking. Thus, the narrowing of SES disparities comes from groups raised in part outside the United States or following norms brought from other countries. This possibility needs more study but implies that declining disparities come from forces outside rather inside the United States.

Consistent with the fundamental cause argument, the most recent trends for majority nativity and ethnic groups demonstrate the stubborn resistance of the disparities to reduction (much less elimination). At least among native-born whites and African Americans, higher taxes and smoking restrictions have not led to reduced educational disparities. Changing policies have lowered smoking but appear to influence the college educated, who are already prone to avoiding unhealthy behaviors, at least as much as the less educated. The results prove consistent with those of Franks and associates (2007) and Ellis and associates (2007), who find that income and education disparities have increased at the same prices have increased.

The results prove less consistent with claims, typically based on comparisons across U.S. states, that disadvantaged groups are most responsive to price increases and clean-air laws (Farrelly and Bray 1998; Farrelly and Engelen 2008). Part of the difference of this study with previous ones comes from the focus on education rather than income. The stronger education disparities may be less amenable to change than the weaker income disparities examined in most other studies (although, according to some supplementary analyses done here, income disparities also appear resistant to change). Perhaps more likely, the difference in findings comes from the focus on changes over time for multiple race and ethnic groups rather than on state-based differences. As others have noted (DeCicca et al. 2008), unmeasured traits such as anti-smoking norms may overlap with strong and weak state policies so as to confound the effects of policies on smoking. In contrast, increases in prices and smoking restrictions that have occurred over the past decade in nearly every state should, if policies have the expected influence, reduce disparities for the full population. That national disparities for most race and ethnic groups remain stable or worsen during a period of remarkable increases in cigarette taxes and smoking restrictions suggests that the policies thus far have done little to equalize SES differences in smoking.

The results emphasize that the context of inequality affects the decision making and responsiveness of groups to policy changes. In principle, higher prices should affect those with fewer resources, but other mechanisms favor high SES groups in changing a health behavior such as smoking. These mechanisms relate to differences in financial, occupational, and educational resources that affect the ability to quit, the perceived benefits of avoiding smoking for longevity, the stress that motivates smoking as a coping device, varied lifestyle norms and
identities, and social support that encourages or discourages smoking. In addition, the crucial importance of education proves consistent with arguments of John Mirowsky and Catherine E. Ross (2003, 2005) that additional schooling promotes healthy behavior through enhanced efficacy and problem-solving skills. As a result, the resources of the highly educated make them better able to respond to disincentives.

The results reinforce calls for vigorous efforts to tailor tobacco control for low SES groups (Bauer et al. 2005; NIH 2007; Sorenson et al. 2004). Tax and clean-air policies have had much benefit for tobacco control and warrant expansion to increase the proximate disincentives of all groups to smoke. However, as noted by Katherine L. Frohlich and Louise Potvin (2008) and illustrated by the results here for smoking, broad population approaches (Rose 1992) may fail to address the sources underlying the risk exposure of vulnerable populations. While tax and clean-air policies lower smoking overall, policies may also need to identify measures that are tailored to less educated groups with the highest smoking (Platt et al. 2002). Such groups include those with high school degrees and some college, whose position relative to college graduates has worsened in recent years. Progress in reducing smoking among the college educated group may come more slowly in the future because average levels have fallen to about 10 percent and now have less room to drop. In contrast, the higher smoking among less educated groups leaves more room for decline and the influence of targeted programs.

These findings are limited by the use of self-reported smoking. Although reliable on average, self reports may reflect bias that varies across education groups. If highly educated smokers, who may face greater stigmatization by workmates, friends, and family, deny their use of cigarettes to interviewers more than less educated smokers, it may artificially increase educational disparities. Confirming studies of reported cigarette use, studies of cotinine levels demonstrate that educational disparities are real (Adda and Cornaglia 2006), but a focus on changes in self-reported smoking by educational level may lead to special measurement problems. Even with accurate self reports, measures based on age of starting, age of quitting, periods of abstinence, intensity of cigarette use, and exposure to secondhand smoke would provide more information. Current smoking status has the advantages of being straightforwardly measured, comparable across time, and critical for health. Still, investigation of past as well as current smoking and consideration of changes in life-course patterns can add to the literature.

References


