Is Cognition a Fundamental Cause of Health Disparities? A Cohort Analysis of Smoking Initiation and Cessation

Abstract
Cognitive epidemiologists argue that IQ, rather than education, is a fundamental cause of health disparities. To test this claim, we utilize the Wisconsin Longitudinal Study to examine smoking behaviors in a cohort that came of age during the period between 1950 and 1960, when the medical evidence, which received significant media attention, demonstrated the link between smoking and cancer. Smoking is an excellent test because of its high impact on mortality, the lack of evidence on the predictive value of IQ, and becayse individual behaviors are a central mechanism through which cognition is expected to affect health. Preliminary analyses demonstrate that those with higher IQs were *more* likely to have started smoking than those with lower IQs, despite the evidence regarding the ill effects of smoking, while educational performance/attainment are strongly and negatively associated with starting smoking. Educational attainment/performance also drives the likelihood of quitting smoking by later life.

Introduction

Socioeconomic status, in particular educational attainment, has a large influence on health and mortality outcomes across time, cohorts and the individual life course leading scholars to argue it is a fundamental cause of health and mortality. Indeed, education health and mortality have actually increased in the last twenty years (Palloni and Thomas 2013; Lauderdale 2001; Meara et al. 2008; Montez et al. 2011; Pappas et. al 1993; White et al. 2003; Lostao et al. 2001; Mackenbach et al. 2003; Lang et al. 1995; Kunst et al. 2005; Jaffe et al. 2008; Sulander et al. 2009; Smith et al. 2002; Khang et al. 2004). This perspective has been called into question by the new subdiscipline of cognitive epidemiology, which assumes that intelligence (measured by IQ), rather than educational attainment, is epidemiologists' true 'fundamental cause' (Deary et al. 2010; Gottfredson 2004). This research has linked IQ to a range of mortality and health outcomes (Whalley & Deary, 2001; Hart, et al., 2003a; Batty, et al., 2009c; Leon, et al., 2009; Young, 2008; Batty et al. 2008; Batty, et al., 2009b; Hart, et al., 2003b; Starr, et al., 2004; Batty, et al., 2005; Batty, et al., 2007b). Broadly, the explanation for the relationship between IQ and health is that it is a function of improved individual behaviors that lead to better health, which is in contrast the structural explanations that underlie fundamental cause theory.

But there are some important limitations to the existing literature exploring the relative contribution of IQ, versus educational attainment, to health and morality outcomes. In particular, though healthy behaviors are a key mechanism by which cognition is assumed to affect health and mortality, there is relatively limited evidence of the impact of IQ on health behaviors, especially in regards to smoking. Smoking, a critical individual level health behavior, causes 1 in 5 deaths. Hence, it provides an interesting case to test the theory posited by cognitive epidemiologists. Second, this research has not accounted for non-cognitive resources, such as conscientiousness, that may confound the relationship between cognition and health. Consequently, we utilize a unique source of longitudinal cohort data—a cohort that came of age during an era when a growing body of evidence established a link between smoking and lung cancer—to examine the links between cognition, education, non-cognitive (e.g. psychological) resources and smoking. Indeed, the first large reduction in cigarette sales came about in the mid 1950s as strong evidence emerged regarding the role of smoking in cancer (Consumer Reports 1953, 1954; Miller and Monahan, 1954). Arguably, individuals with higher IQs should have been the first to alter their behavior given this emerging information. Further, our data captures a key limitation of the existing literature, specifically the inattention to non-cognitive resources that are highly correlated with both IQ and educational attainment. Contrary to what cognitive epidemiology would have predicted, we find that individuals with higher IQ individuals were actually more likely to have ever smoked. Further, in terms of who eventually quits by the time these individuals reach their mid-60s, it is largely driven by educational factors, including academic performance and attainment.

SES or IQ as the Fundamental Cause?

The strength and consistency of the link between SES and health over time has lead scholars to call socioeconomic status a "fundamental cause" of disease (Link and Phelan 1995). Indeed, the relationship between socioeconomic status (SES) and health is one of the best-documented in the social and medical sciences (e.g., Elo 2009). Those with higher levels of education, income, occupational status, and other markers of socioeconomic status have better health (e.g., Adler, Boyce, Chesney, Cohen, Folkman, Kahn, and Syme 1994), live longer lives (e.g., Rogers, Hummer, and Nam 2000), and engage in healthier behaviors (e.g., Pampel, Krueger, and Denney 2010) than those of lower socioeconomic status. The fundamental cause

perspective argues that SES is so strongly linked to a variety of measures of health across time and place because SES confers a variety of health-promoting resources such as "knowledge, money, power, prestige, and beneficial social connections" (Link and Phelan 1995; Link, Phelan, Miech, and Westin 2008: 72). A consequence of the diversity and flexibility of these resources is that higher-SES individuals continue to enjoy a health advantage even as the risk and protective factors for disease change over time. As such, socioeconomic status constitutes an enduring source of health inequalities.

However, a central challenge to this perspective has been posited, and increasingly tested, by the new sub-discipline of 'cognitive epidemiology.' This sub-discipline argues that early life cognitive functioning is the fundamental cause of health and mortality disparities rather than social determinants like educational attainment. This research has demonstrated that, in addition to overall mortality (Whalley & Deary, 2001; Hart, et al., 2003a; Batty, et al., 2009c; Leon, et al., 2009), measures of cognitive ability such as IQ, are associated with accidental deaths (Young, 2008; Batty, et al., 2009b), homicide (Batty, et al., 2008), and hypertension, stroke, and cardiovascular disease (Hart, et al., 2003b; Starr, et al., 2004; Batty, et al., 2005; Batty, et al., 2007b).

Healthy behaviors are the central mechanism through which these differences are hypothesized to emerge. While fundamental cause theory captures behaviors, for example how individuals use financial or educational resources to respond to new technologies, the perspective assumes a large role for how structural factors influence health. For example, access to educational attainment influences the kinds of occupations people enter, which in turn, influences health. In contrast, cognitive epidemiology has focused mostly on the role of individual behaviors and how they are influenced by cognitive function. In short, it is about the choices individuals make. Thus, cognitive epidemiologists argue that individuals with lower IQ levels may have more difficulty interpreting and understanding messages related to healthy behaviors, such as smoking, which place people at risk for conditions, such as cardiovascular diseases and strokes, which are linked to IQ and overall mortality (Gottfredson and Geary 2004).

Given the individualistic nature of this perspective, the ideal test of this theory is to focus on the individual behaviors though which cognitive resources are utilized to impact health, rather than a focus on overall mortality, or even cause specific mortality, which may be in part a function of structural factors. For example, cardiovascular disease is caused not only be health behaviors, such as diet, exercise, and smoking, it is also influenced by environmental factors such as occupation and pollution. In short, while individuals ultimately make a choice to pick up a cigarette, though of course even this choice is influenced by structural factors, no individual makes a choice to have heart disease. Further, there is evidence that the health consequences of health behaviors varies across socioeconomic groups. Consequently, if one wants to clearly test the claims of cognitive epidemiologists, IQ should exert a strong and consistent influence on health behaviors, of which individuals exert more individual control.

Among health behaviors, smoking is arguably the strongest predictor of disease and mortality and thus of particular interest (Mokdad, Marks, Stroup, Gerberding 2004; Centers for Disease Control 2008). While the research on alcohol consumption and overweight and obesity displays conflicting evidence about the ultimate impact on health, and even overall mortality, there is no such inconsistency in the relationship between smoking and health outcomes.

To date, however, the research linking IQ and smoking is relatively small and has produced conflicting results. Some studies have found that IQ predicts both onset, and for those who do smoke, duration and quantity of smoking, even controlling for early childhood

characteristics and adult educational attainment (Osler et al. 2008; Weiser et al. 2009; Hemmingsson et al. 2008). Some studies have only found a relationship between IQ and the propensity to quit, not the propensity to start smoking after controlling for early childhood factors and adult socioeconomic status (Taylor et al. 2003). Other studies have found that controlling for childhood and adult socioeconomic factors (especially education), fully explains the relationship between IQ and smoking (Batty et al. 2007; Modig and Berman 2012).

There are, however, limitations to the existing literature. First, this literature generally has paid little attention to historical context. Patterns of smoking behavior, however, have been impacted by known risks associated with these behaviors. For much of the first part of the 20th century, smoking was not seen as a 'risky' behavior, hence the role that cognition might play in shaping these behaviors would likely differ than later in the 20th century when the risks associated with smoking were known. Indeed, this exact pattern has already been demonstrated for educational attainment—in the middle of the 20th century there was no educational gradient in smoking, but by the end of the 20th century, a strong educational gradient had emerged (Pampel 2005; Denney, Rogers, Hummer, and Pampel 2010). Thus, the relationship between IQ and smoking will likely vary over different cohorts, but also over the life course of individuals within a cohort.

The case of smoking in the 1939 birth cohort provides an especially interesting test. While many focus on the 1964 Surgeon General's report as the watershed event in awakening the public to the dangers of smoking, this is somewhat erroneous. In fact, in 1956, the Surgeon General released a comprehensive study examining the existing evidence on smoking and cancer, which concluded that, "The Public Health Service feels the weight of the evidence is increasingly pointing in one direction: that excessive smoking is one of the causative factors in lung cancer' " (U.S. Department of Health, Education and Welfare, Public Health Service 1964: 7). Indeed, throughout the 1950s, there was increasing media coverage in outlets including Time Magazine, Reader's Digest, and Life reviewing this growing body of research. In fact, 1953 and 1954, along with the Great Depression and the end of World War II, were the only periods that experienced a decline in cigarette consumption (Consumer Reports 1953, 1954; Miller and Monahan, 1954). Thus, for the WLS cohort, information campaigns surrounding the dangers with smoking—that appeared for a while to influence sales of cigarettes—were emerging during their early adolescence—just prior to when many took up smoking. Consequently, one might hypothesize that high IQ individuals would be among the first to be aware of these issues and correspondingly alter their behavior.

Second, while most of the literature has accounted for individual educational attainment as an explanatory mechanism, it generally has not accounted for potentially confounding 'non-cognitive' factors that could influence both IQ and smoking initiation and duration. For example, there is evidence that academic achievement is not just a function of IQ, but is a function of other non-cognitive skills that allow individuals to excel in school—ranging from discipline to curiosity (Duckworth and Seligman 2005). Indeed, there is growing body of evidence that these factors are critical to understanding the relationship between IQ and health (Noftle et al. 2007). Psychological and behavioral skills are correlated with cognitive functioning (Calero et al. 2007; Conti et al. 2010; Hauser and Palloni, 2011). A recent summary of results from research on brain structure and emotional development in children notes that "stated simply, as young children develop, their early emotional experiences literally become embedded in the architecture of their brains" (National Scientific Council on the Developing Child 2011).

The Present Study: Smoking as a Case Study for Fundamental Cause Theory (Not quite right)

In the present study, we examine the implications of socioeconomic status and IQ for smoking behavior in the Wisconsin Longitudinal Study (WLS). The WLS consists of a one third random sample of the Wisconsin high school class of 1957, in which all members were born in approximately 1939. Smoking is cited as a classic example of how socioeconomic status operates as a fundamental cause of disease (Link and Phelan 1995). Smoking, which was initially not patterned or even positively patterned by socioeconomic in the early decades of the twentieth century, became increasingly inversely patterned with socioeconomic status (Pampel 2005). An examination of the WLS birth cohort is of interest for several reasons. First, this cohort provides an excellent test of cognitive epidemiology theories—in large part because they came of age during an era when a growing body of evidence established a link between smoking and lung cancer. Indeed, the first large reduction in cigarette sales came about in the mid 1950s as strong evidence emerged regarding the role of smoking in cancer (Consumer Reports 1953, 1954; Miller and Monahan, 1954). Those with higher IQs should have been among the first to integrate this evidence in their health behaviors—in short, they should be early adopters. Third, because the WLS contains detailed measures of both IQ and academic performance early in life, the present study enables a closer look at how factors (potentially) related to education—intelligence and academic performance—influence *both* smoking imitation and cessation within a cohort. As such, the present study affords an examination of how the resources that socioeconomic status confers are contingent on context—in this case, public knowledge of the health risks of smoking.

Data and Methods

Data

This study uses data from the Wisconsin Longitudinal Study (WLS), a longitudinal study of a one-third random sample of 1957 high school graduates from1957 (~age 18) through 2004 (~age 63). The WLS contains detailed measures of respondents' family background, educational and occupational histories, earnings, family, and health. A cohort analysis is well-suited to test hypotheses, as prior research notes cohort shifts in smoking that vary by gender (Pampel 2001), and the life course patterning of smoking behavior may extend over several decades, with smoking initiation in adolescence but smoking cessation among smokers potentially not occurring for several decades (if at all). In addition, women in the WLS belong to the birth cohort (1935-1939) with have the highest prevalence of ever-smoking of any birth cohort (U.S. Department of Health and Human Services 2014). By definition, everyone in the sample has at least a high school degree. In addition, the overwhelming majority of respondents are white. While the sample does not permit an examination of those with less than a high school education or persons of color, the homogeneity of this sample provides an important advantage. Cultural (and racial) differences in the historical and socioeconomic patterning of smoking have been identified prior research (Pampel 2001). The relative homogeneity of our sample in many respects (including cultural background) helps us to rule out some difficult-to-measure factors as competing explanations for our findings.

Measures

Dependent Variables: Ever-Smoking and Quitting among Ever-Smokers

We examine two smoking outcomes in the 2004 wave. First, whether the respondent reports being a never smoker(=1) or ever smoker (=0). Second, among respondents who are ever smokers, whether they are current smokers(=1) or former smokers(=0). We model ever-smoking and current smoking separately for several reasons. Smoking initiation (never versus ever) and smoking cessation (current v. former) represent distinct stages in smoking behavior and may have different determinants (Gilman, Abrams, and Bilka 2003). Further, the process of smoking initiation typically occurs in adolescence, while smoking cessation may not occur until much later in adulthood (U.S. Department of Health and Human Services 2014). In addition, practical considerations guide our decision to use two dependent variables; while everyone is "at risk" of smoking initiation, only those who are ever-smokers have the opportunity to quit.

Childhood IQ

We include a measure of childhood IQ. This measure is based on the respondent's score on the Henmon-Nelson Test of Mental Ability from either the freshman or junior year of high school. Scores are coded into quartiles, with higher quartiles representing higher test scores (bottom quartile=reference).

Family Socioeconomic Status

We include several measures of the graduate's family's socioeconomic status when the graduate was in adolescence. These include: mother's and father's education (in years), average childhood family income quintile (from 1957-1960 Wisconsin State tax records; lowest quintile=reference), mother's employment status (1=working, 0=not working), father's occupational education (the proportion of workers in father's occupational with at least some college education) (Warren and Hauser 1997), and whether the graduate grew up in a single parent family (1=yes, 0=no).

High School Academic Performance

High school rank percentile is calculated as (100 – [(rank in class based on grades/ [# of students in class]) × 100]) and is then recoded into quartiles. High school rank is treated as ordinal, with higher quartiles representing better academic performance (bottom quartile=reference). Because high school rank may reflect teacher bias as well as student motivation, we include two additional measures primarily as controls. First, whether the graduate's teacher noted that the graduate was an "outstanding" student. Second, whether the graduate reported finding the studies "interesting," as opposed to "uninteresting" or "no special influence" ("interesting"=1, "uninteresting" or "no special influence"=0). These measures were all collected in 1957.

Education

Education is assessed in the 1975 wave of data, when graduates are approximately 35 years old and the vast majority had achieved their highest degree. Education is coded as high school graduate(=reference), some college(=1), or college graduate or post-college education(=2). Results are substantively similar if the "college or more" group is broken into college degree and post-college education.

Analytic Strategy

Five logistic regression models were estimated to model the log odds of a). being a never(=1) versus ever(=0) smoker and b). being a current(=1) versus former smoker. We conduct chow tests to clarify whether findings differ by gender and present results by gender when they

do. We present marginal effects with other covariates held at their means (Long and Freese 2006). Results can be interpreted as probabilities.

Model 1 only includes IQ quartile in order to assess the baseline relationship between IQ and smoking behaviors. Model 2 includes IQ quartile and family socioeconomic status variables (mother's education, father's education, parental income quintiles, whether the mother worked outside the home when the respondent was 16 years old, father's occupational education, and whether the respondent grew up in a single parent household). We include family socioeconomic status for two reasons. First, it may confound the relationship between IQ and smoking. Second, family socioeconomic status may have independent associations with smoking behavior, as family SES may be an important marker of socioeconomic status for individuals early in the life course who have not yet completed school, entered the labor force, or acquired substantial earnings, though they may be initiating health behaviors such as smoking. Model 3 includes IQ quartile, family socioeconomic status, and high school academic performance variables (high school rank quartile, whether respondent reported finding studies interesting, and whether teacher reported the graduate as an "outstanding" student). Academic performance has been previously identified as associated with smoking behavior (Morin, Rodriguez, Fallu, Maïano, and Janosz 2012), and further, its inclusion may clarify the relationship between IQ and smoking, as IQ and academic performance are correlated in the WLS at about 0.60, but are hypothesized to operate via distinct pathways (Herd 2010). Model 4 includes IQ, family socioeconomic status, and education, as education strongly patterns smoking behavior (Pampel, Krueger, and Denney 2010). Model 5 includes IQ, family socioeconomic status, high school academic performance, and education. Given that these factors are likely correlated with one another, including all these factors together facilitates their interpretation and our conceptual understanding of their independent roles in smoking behavior.

Complete information was available for 82% (n=5,526) of the 6,739 respondents with complete information on the smoking variable. Because missing data may bias results (Acock 2005), we utilized multiple imputation using chained equations ("mi estimate chained"), which can accommodate an arbitrary pattern of missing data. We include all independent covariates in the imputation model and present results pooled from ten iterations. All analyses were conducted in Stata 13.0.

Results

Contrary to what cognitive epidemiology would have predicted, we find that individuals with higher IQ individuals were actually more likely to have ever smoked. Further, in terms of who eventually quits by the time these individuals reach their mid-60s, it is largely driven by educational factors, including academic performance and attainment.

Table 1 presents descriptive statistics for dependent and independent variables for men and women. Consistent with prior work examining this cohort, women are more likely to be never smokers than men. However, when we consider ever-smokers, women are also more likely to be current smokers than men. Twenty-four percent (0.12/0.12+0.37) of women ever-smokers are still currently smoking, compared with 21% (0.13/0.13+0.50) of men also consistent with some prior studies. Information from retrospective smoking histories collected in 2004 reveal that nearly about 73% of male ever-smokers and 62% of female ever-smokers began smoking by age 18 (i.e. in high school or before), and over 90% of both men and women ever-smokers started by age 21 (not shown). Both the mean/median age of smoking cessation among ever-smokers was about age 40 for both men and women (not shown).

While the distribution of IQ by quartile does not differ by gender, women are more likely to be in higher high school rank quartiles than men, though they also have lower educational attainment. The mothers of female respondents had slightly lower education than the mothers of male respondents. Male respondents were also slightly more likely than female respondents to have mothers who worked outside the home when the respondent was 16 years old. Women were more likely to report their studies as "interesting" than men and were also more likely to be rated as "outstanding" by their teachers. Father's education, father's occupational education, parental income quintile, and the proportion growing up in a single-parent family did not differ by gender.

Never versus Ever Smoking

Table 2 presents marginal effects reflecting the probability of being a never smoker versus an ever smoker. Across models, Chow tests indicate that overall, coefficients differ by gender and thus, models should be stratified by gender. Model 1, which only includes IQ, shows that IQ is not statistically significantly related to never smoking for men. Among women, those in the second and third quartiles are 4% and 5% less likely to be never smokers, respectively, compared with women in the lowest IQ quartile, though these associations are only marginally statistically significant. Gender differences are not statistically significant.

Model 2 includes IQ quartile and family background variables. IQ is not associated with never- versus ever-smoking for either men or women. Parental income was not associated with never-smoking for men at the 0.05 level, though the third income quintile is marginally associated with a lower probability of never-smoking compared with the bottom quitile. For women, however, higher parental income was strongly statistically significantly associated with a lower probability of never-smoking. Compared with women in the bottom parental income quintile, women in the second parental income quintile were 7% less likely to be never smokers, increasing to a 17% lower probability of being a never smoker in the top parental income quintile. Chow tests indicate statistically significant gender differences in the associations between the top two income quintiles and never-smoking. Both men and women with working mothers were more likely to be never-smokers, though this association was not statistically significantly different by gender. For women, growing up in a single parent household was associated with an 8% lower probability of being a never-smoker.

Model 3 includes IQ quartile, family socioeconomic background, and high school academic performance variables. While in Model 2 IQ was not associated with being a never smoker among men, when controlling for high school academic performance, the third and top IQ quartiles are associated with 7% and 13% *lower* probability, respectively, of being a never smoker compared with the bottom IQ quartile. The negative association between IQ and never-smoking is even more dramatic among women. Compared with those in the bottom IQ quartile, women in the second, third, and fourth IQ quartiles have 10%, 15%, and 19% lower probabilities of being never-smokers, respectively. For both men and women, higher high school rank quartile is positively associated with never-smoking. Among men, those in the second, third, and top high school rank quartile have 8%, 16% and 30% higher probabilities of never-smoking, respectively, compared with men in the bottom rank quartile. Among women, those in the second, third, and top high school rank quartiles have 7%, 14%, and 30% higher probabilities of never-smoking, compared with those in the bottom high school rank quartile. The associations between parental income and having a working mother (for both genders) and growing up with a single parent (for women) with never-smoking are similar to results in Model 2.

Model 4 includes IQ quintile, family socioeconomic background, and education variables. For men, being in the top IQ quartile is associated with 6% lower probability of being a never smoker compared with the bottom quartile. IQ is not associated with never-smoking for women. Gender differences in the strength of these associations between IQ and never-smoking are statistically significant at the 0.05 level. Compared with those that have a high school education, men with some college have a 6% higher probability of being a never smoker, and men with a college degree have an almost 20% higher probability of being a never smoker. Among women, those with a college education are about 12% more likely to be never smokers compared with those with a high school degree. Gender differences in the strength of these associations of education level with never-smoking are statistically significant at the 0.05 level. Associations between family background variables and never-smoking are similar to prior models.

Model 5 includes IQ quartile, family socioeconomic background, high school academic performance, and education variables. Among men, those in the third and top IQ quartiles have 9% and 16% lower probabilities of being never smokers, compared with those in the bottom IQ quartile. Among women, those in the second, third, and top IQ quartiles have 9%, 15%, and 20% lower probabilities, respectively, of being never-smokers, compared with those in the bottom IQ quartile. As in Model 3, higher high school rank quartile is associated with higher probability of never-smoking for both men and women, with similar magnitudes to Model 3. Education coefficients are attenuated and in some cases no longer statistically significant for men and women. Among men, those with a college degree are 14% more likely to be never-smokers, compared to those with a high school degree, and the relationship between some college and never-smoking is no longer statistically significant. Among women, those with a college degree are 6% more likely to be never-smokers compared to those with a high school degree, though this relationship is only marginally statistically significant. Associations between family background variables and never-smoking are similar to those in prior models.

Current versus Former Smoking

Table 3 presents marginal effects predicting the probability of being a current smoker versus a former smoker. Chow tests fail to reject the null hypothesis that coefficients overall do not differ by gender. As such, we present models pooled by gender. As an additional test for gender differences, we examined Chow tests of gender differences in specific coefficients and also ran gender interactions in the pooled model. Both sets of tests overwhelmingly indicated that the predictors of smoking cessation did not differ by gender.

Across models, women are more likely to be current smokers versus former smokers (3-4% higher probability, depending on model). In Model 1, which only includes gender and IQ quartile, those in the third and top IQ quartile are 5% and 9% less likely to be current (versus former) smokers, compared with those in the bottom IQ quartile. Adding family background in Model 2 somewhat attenuates these associations. Across models, none of the family background variables are associated with current smoking at the 0.05 level. Adding measures of high school academic performance in Model 3 reduces the association between IQ quartile and current smoking to non-significance for the third quartile and marginal significance for the top quartile. Further, those in the secondand top high school rank quartiles are 5% and 6% less likely, respectively, to be current smokers compared with those in the bottom high school rank quartile. Model 4 includes gender, IQ quartile, family background, and education. Accounting for educational attainment attenuates the coefficient for top IQ quartile, reducing the association

between the top quartile from -about 8% lower probability of being a current smoker in Model 2 to about 6% lower probability of being a current smoker in Model 4. In addition, the negative association between the third IQ quartile and current smoking in Model 2 loses statistical significance when educational attainment is accounted for. Those with a college degree or more are 7% less likely to be current smokers, compared with those with only a high school degree. In Model 5, we include IQ quartile, family background, high school academic performance, and education variables. In this model, IQ is not statistically significantly related to being a current versus former smoker. Those in the second and top high school rank quartiles are each about 5%less likely to be current smokers, respectively, compared with the bottom rank quartile, though this relationship is only marginally significant for the top quartile. After accounting for high school academic performance the negative association between college degree and current smoking is somewhat attenuated compared with Model 4, but those with a college degree are still 6% less likely to be current smokers compared with high school graduates.

Supplementary Analysis

As a robustness check, we also ran a multinomial logistic regression estimating the log odds of being a never smoker, current smoker, or former smoker(=reference). Results were substantively identical to the logistic regression models presented. We also included a control for whether any adult in the graduate's home smoked when the graduate was 16 years old. Results did not differ whether this indicator was included or not. In addition, we also estimated tobit models predicting years of smoking among ever-smokers. Again, results were substantively very similar to those presented in the Results section for current versus former smokers. Finally, we also estimated all analyses without imputed cases. Substantive findings were identical.

Discussion

Smoking is commonly referred to as a classic example of the fundamental cause of disease perspective. The claim is that class differences in smoking only emerged when it became clear that cigarette smoking was a significant risk factor for mortality. These, analyses, however find that when focusing on a cohort born in 1939, which came of age just prior to the shift in our understanding of the risks associated with smoking, reveals a more nuanced narrative. While our findings that education is negatively associated with smoking initiation and positively associated with smoking cessation replicate numerous past studies (Pampel, Krueger, and Denney 2010), several of our other findings provide a more complicated picture of fundamental cause theory, and the social patterning of smoking more generally.

We find that IQ is *negatively* associated with being a never-smoking, contrary to the expectations of cognitive epidemiologists who argue that higher IQ should foster healthier behaviors. Furthermore, the strong relationship between higher IQ and lower probability of never smoking only emerges after high school academic performance is controlled for. High school academic performance, though positively correlated with IQ, also reflects a broad range of skills and abilities ranging from self-discipline to personality characteristics (Duckworth and Seligman 2005; Hauser and Palloni 2011). Not controlling for high school academic performance suppresses the negative association between IQ and never-smoking since IQ and academic performance are themselves positively correlated. In addition, the relationship between IQ and never-smoking becomes even stronger when both academic performance and education are controlled for—with those in the highest IQ quartile as much as 20% more likely to be ever-

smokers compared with those in the lowest quartile. As when looking at IQ and academic performance, not accounting for the positive correlation between IQ and education biases the association between IQ and never smoking towards zero. These findings indicate the critical importance of accounting for academic performance and educational attainment in assessments of the role of IQ in smoking initiation. Why is IQ negatively associated with never-smoking after accounting for academic performance, education, and other factors? One explanation lies in the advertising messages targeted towards young people, which emphasized independence for both men and women. These messages might appeal especially to high IQ individuals, who are also more likely to assert autonomy (Albert and Runco 1988). To the extent that high IQ children are recognized as exceptional, they may also be socialized to believe that rules and expectations that apply to lower IQ children do not apply to them. In addition, some prior work also suggests that high IQ individuals may engage in riskier behavior as evidenced by higher reports of nonfatal accidents in several categories for both women and men (Batty et al. 2007). This is consistent with our findings that the relationship between IQ and never-smoking does not vary by gender.

High school academic performance has an independent and positive association with never smoking. High school academic performance may facilitate abstinence from the harmful behavior of smoking via improved cognitive abilities. To the extent that academic performance reflects things learned in school, it may facilitate the processing of information related to healthy behaviors (Herd 2010), which might include the public health messages warning of smoking's dangers disseminated in the 1950s. In addition, high school academic performance reflects to some extent the successful navigation of high school—an important social context early in the life course. High school academic rank partially reflects a student's ability to conform to social expectations. As McLeod and colleagues state, "beyond the classroom, schools reward students whose behaviors contribute to maintaining social order and punish students whose behaviors are disruptive or threatening" (2012: 484). Deviant behaviors such as smoking are precisely the discouraged behaviors that conforming high-achieving students would eschew.

Our findings regarding the predictors of smoking cessation present a simpler story. We see some evidence that higher high school rank is associated with greater smoking cessation, as is having a college degree or more. After accounting for academic performance and educational attainment, IQ is not associated with smoking cessation. Tests for gender differences were not statistically significant. It is however important to highlight the persistent, elevated probability of women being more likely to be current- versus former-smokers, which is not explained by women's lower educational attainment. This finding is echoed in many other studies. A variety of explanations have been proposed to explain why women, who are still less likely to smoke than men, are more likely to have trouble quitting. These explanations include: differential stress exposure (Graham 1987), body weight concerns (Pampel 2005), and potential genetically-based gender difference s in nicotine dependence among the increasingly select women who do take up smoking (Boardman, Blalock, and Pampel 2010).

Like any study, there are also some caveats to our findings. First, we examine a unique cohort that came of age in the 1950s. While our sample is ideally situated to examine the smoking experiences across the life course of a cohort that came of age just as the health risks of smoking became widely known, these findings are cohort-specific. Indeed, the changing dynamics of smoking behaviors and its social and economic determinants are what have lead smoking to be a classic case study of fundamental cause theory. Our findings highlight the importance of situating health behaviors in historical context which considers the state of scientific knowledge, gender norms, and cultural forces. Relatedly, our findings cannot speak to

important racial variation given that our sample is overwhelmingly white. Nor are we able to examine those with less than a high school education, though it is important to note that our sample is representative of about two-thirds of members of this birth cohort (Hauser and Palloni, 2011). In addition, there are some concerns regarding selective mortality in models examining smoking cessation, when respondents are in their mid-60s, particularly since smoking is so strongly linked to mortality. As such, our sample for smoking cessation represents a more physically robust sub-sample of the cohort, likely yielding conservative estimates. Despite these limitations, our study provides advances fundamental cause theory by incorporating gender and challenging IQ as the "true" fundamental cause of the relationship between socioeconomic status and smoking.

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Table 1. Summary statistics, Wisconsin Longitudinal Study, 1957-2004, (N= 6739)

	Men (n=3103)			Women (n=3636)		Range
	Proportion/Mean	SE		Proportion/Mean	SE	
Smoking			***			
Never	0.37	0.01		0.51	0.01	
Former	0.50	0.01		0.37	0.01	
Current	0.13	0.01		0.12	0.01	
IQ						
Bottom quartile	0.22	0.01		0.21	0.01	
Second quartile	0.24	0.01		0.26	0.01	
Third quartile	0.26	0.01		0.26	0.01	
Top quartile	0.28	0.01		0.27	0.01	
Mother's education	10.60	0.05	**	10.36	0.05	0-20
Father's education	9.80	0.06		9.72	0.06	0-27
Mother worked	0.65	0.01	*	0.62	0.01	0-1
Father's occupational education	207.92	4.06		210.07	3.68	8-995
Grew up in single parent household	0.10	0.01		0.10	0.00	0-1
Parental income quintile						
Bottome quintile	0.19	0.01		0.20	0.01	
Second quintile	0.20	0.01		0.21	0.01	
Third quintile	0.21	0.01		0.20	0.01	
Fourth quintile	0.21	0.01		0.20	0.01	
Top quintile	0.19	0.01		0.19	0.01	
High school rank quartile			***			
Bottom quartile	0.28	0.01		0.15	0.01	
Second quartile	0.27	0.01		0.22	0.01	
Third quartile	0.25	0.01		0.29	0.01	
Top quartile	0.21	0.01		0.35	0.01	
Teacher rated student outstanding	0.10	0.01	***	0.12	0.01	0-1
Found studies interesting	0.57	0.01	*	0.62	0.01	0-1
Education			***			
High school	0.54	0.01		0.69	0.01	
Some college	0.14	0.01		0.13	0.01	
College or more	0.31	0.01		0.19	0.01	

Note: *p<0.05; **p<0.01; ***p<0.001 indicate statistically significant gender differences (two-tailed tests).

Table 2. Marginal effects at means from logistic regression of never versus ever smoking by gender, Wisconsin Longitudinal Study, 1957-2004

	Model 1				Model 2				Model 3				Model 4				Model 5			
	Men		Women		Men		Women		Men		Women		Men		Women		Men		Women	
	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE
IQ																				
Bottom quartile	(ref.)		(ref.)		(ref.)		(ref.)		(ref.)		(ref.)		(ref.)		(ref.)		(ref.)		(ref.)	
Second quartile	0.01	0.03	-0.04	0.02 †	0.01	0.03	-0.03	0.02	-0.04	0.03	-0.10	0.03 ***	**-0.01**	**0.03**	**-0.03**	**0.02**	-0.04	0.03	-0.09	0.03 ***
Third quartile	0.01	0.03	-0.05	0.02 †	0.02	0.03	-0.03	0.02	-0.07	0.03 *	-0.15	0.03 ***	**-0.03**	**0.03**	**-0.04**	**0.03**	-0.09	0.03 **	-0.15	0.03 ***
Top quartile	0.02	0.02	-0.04	0.02	0.03	0.03	0.00	0.03	-0.13	0.03 ***	-0.19	0.03 ***	**-0.06**	**0.03** *	**-0.03**	**0.03**	-0.16	0.03 ***	-0.20	0.03 ***
Mother's education					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Father's education					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00 †	0.00	0.00	-0.01	0.00 †	0.00	0.00
Parental income quintile																				
Bottome quintile					(ref.)		(ref.)		(ref.)		(ref.)		(ref.)		(ref.)		(ref.)		(ref.)	
Second quintile					-0.02	0.03	-0.07	0.03 *	-0.03	0.03	-0.07	0.03 *	-0.03	0.03	-0.07	0.03 *	-0.03	0.03	-0.07	0.03 *
Third quintile					-0.05	0.03 †	-0.14	0.03 ***	-0.06	0.03 *	-0.13	0.03 ***	-0.07	0.03 *	-0.13	0.03 ***	-0.07	0.03 *	-0.13	0.03 ***
Fourth quintile					**-0.01**	**0.03**	**-0.15**	**0.03** ***	**-0.02**	**0.03**	**-0.14**	**0.03** ***	**-0.03**	**0.03**	**-0.15**	**0.03** ***	**-0.02**	**0.03**	**-0.14**	**0.03** ***
Top quintile					**-0.03**	**0.03**	**-0.17**	**0.03** ***	**-0.03**	**0.03**	**-0.17**	**0.03** ***	**-0.05**	**0.03**	**-0.19**	**0.03** ***	**-0.05**	**0.03**	**-0.17**	**0.03** ***
Mother worked					0.05	0.02 *	0.06	0.02 **	0.05	0.02 *	0.06	0.02 **	0.05	0.02 **	0.06	0.02 **	0.05	0.02 **	0.06	0.02 **
Father's occupational education					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 *	0.00	0.00	0.00	0.00 †	0.00	0.00
Grew up in single parent household					0.00	0.03	-0.08	0.03 **	0.01	0.03	-0.06	0.03 *	0.00	0.03	-0.08	0.03 **	0.01	0.03	-0.06	0.03 *
High school rank quartile																				
Bottom quartile									(ref.)		(ref.)						(ref.)		(ref.)	
Second quartile									0.08	0.02 **	0.07	0.03 *					0.07	0.02 **	0.07	0.03 *
Third quartile									0.16	0.03 ***	0.14	0.03 ***					0.14	0.03 ***	0.14	0.03 ***
Top quartile									0.27	0.03 ***	0.30	0.03 ***					0.24	0.03 ***	0.29	0.03 ***
Teacher rated student outstanding									-0.02	0.03	0.03	0.03					-0.04	0.03	0.02	0.03
Found studies interesting									0.05	0.02 *	0.03	0.02 †					0.02	0.02	0.03	0.02
Education																				
High school													(ref.)		(ref.)		(ref.)		(ref.)	
Some college													**0.06**	**0.03** *	**-0.01**	**0.03**	0.03	0.03	-0.04	0.03
College or more													**0.20**	**0.02** ***	**0.12**	**0.02** ***	**0.14**	**0.03** ***	**0.06**	**0.03** *
n	3103		3636		3103		3636		3103		3636		3103		3636		3103		3636	

Note: *p<0.05; **p<0.01; ***p<0.001.
Chow tests rejected the null hypothesis of equality of all coefficients across gender for all models.
Chow tests evaluating the equality of each coefficient across gender within model were also tested, those differences statistically significant at the 0.05 level are indicated in bold.

Table 3. Marginal effects at means from logistic regression of current versus former smoking, Wisconsin Longitudinal Study, 1957-2004

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE	Marginal effects	SE
Female	0.04	0.01 *	0.03	0.01 *	0.04	0.01 **	0.03	0.01 †	0.04	0.01 *
IQ										
Bottom quartile	(ref.)		(ref.)		(ref.)		(ref.)		(ref.)	
Second quartile	-0.03	0.02	-0.02	0.02	-0.01	0.02	-0.02	0.02	-0.01	0.02
Third quartile	-0.05	0.02 *	-0.04	0.02 *	-0.02	0.02	-0.03	0.02	-0.02	0.02
Top quartile	-0.09	0.02 ***	-0.08	0.02 ***	-0.04	0.02 †	-0.06	0.02 ***	-0.03	0.02
Mother's education			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Father's education			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Parental income quintile										
Bottome quintile			(ref.)		(ref.)		(ref.)		(ref.)	
Second quintile			-0.02	0.02	-0.02	0.02	-0.01	0.02	-0.02	0.02
Third quintile			-0.01	0.02	-0.01	0.02	-0.01	0.02	0.00	0.02
Fourth quintile			0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
Top quintile			0.01	0.03	0.01	0.03	0.02	0.03	0.02	0.03
Mother worked			0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
Father's occupational education			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grew up in single parent household			0.04	0.02 †	0.04	0.02 †	0.04	0.02 †	0.04	0.02 †
High school rank quartile										
Bottom quartile					(ref.)				(ref.)	
Second quartile					-0.05	0.02 *			-0.05	0.02 *
Third quartile					-0.04	0.02			-0.03	0.02
Top quartile					-0.06	0.03 *			-0.05	0.03 †
Teacher rated student outstanding					-0.04	0.03			-0.03	0.03
Found studies interesting					-0.02	0.02			-0.01	0.02
Education										
High school							(ref.)		(ref.)	
Some college							0.02	0.02	0.03	0.02
College or more							-0.07	0.02 ***	-0.06	0.02 **
n	3737		3737		3737		3737		3737	

Note: *p<0.05; **p<0.01; ***p<0.001.
Chow tests failed to reject the null hypothesis of equality of all coefficients across models, with the exception of Model 1.
Chow tests evaluating the equality of each coefficient across gender were also tested but were not statistically significant at the 0.05 level.