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Understanding the links between education and smoking

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ABSTRACT

This study extends the theoretical and empirical literature on the relationship between education and smoking by focusing on the life course links between experiences from adolescence and health outcomes in adulthood. Differences in smoking by completed education are apparent at ages 12–18, long before that education is acquired. I use characteristics from the teenage years, including social networks, future expectations, and school experiences measured before the start of smoking regularly to predict smoking in adulthood. Results show that school policies, peers, and youths' mortality expectations predict smoking in adulthood but that college aspirations and analytical skills do not. I also show that smoking status at age 16 predicts both completed education and adult smoking, controlling for an extensive set of covariates. Overall, educational inequalities in smoking are better understood as a bundling of advantageous statuses that develops in childhood, rather than the effect of education producing better health.

1. Introduction

Across nearly every dimension of health, those with more education experience better outcomes, adopt healthier behaviors, and live longer. These large and robust effects of education on health endure even when income, wealth, and previous health status are controlled (Smith, 2007; Grossman and Kaestner, 1997; Preston and Elo, 1995; Williams and Collins, 1995; Kitagawa and Hauser, 1973). Using quasi-natural experiments such as policy changes and expansions in school availability or structural modeling strategies, studies show that at least part of the relationship between education and health-related outcomes can be isolated from confounding factors and considered causal (Chandola et al., 2006; Grossman, 2006; Lleras-Muney, 2005).

Differences in cigarette smoking by education represent one of the deadliest of such inequalities. Smoking is the leading behavioral cause of death in the U.S., with smoking-related illnesses accounting for nearly one out of every five deaths each year. Smoking, however, takes its toll primary on individuals with less education. In 2009, about a quarter of those with high school or less completed were current smokers compared to 20% of those with an associate degree, 11% of those with an undergraduate degree, and 5.6% of those with a graduate degree (Centers for Disease Control and Prevention CDC, 2012, 2010). Educational inequalities in smoking are an important public health concern, and a sobering example of the many advantages experienced by those with more schooling.

But is this association between education and smoking casual? If it is, and we understood which aspects of schooling caused individuals not to smoke, then educational policy could have massive health dividends. From a public health perspective this is especially promising because, while Americans are divided on issues of health infrastructure, support, and

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regulation, we are remarkably unified in our support of educational opportunities (Brint, 2011). Moreover, if increasing individuals' education causes them to smoke less, then this would only add to the many social and economic benefits that are linked to educational attainment. In contrast, if the relationship between education and smoking is non-causal, then the observed gradients are instead explained by unobserved factors that predict both statuses, making the disparities more difficult to address.

Understanding the causal links between education and smoking is complicated by an important problem that is often ignored in the existing literature. At the population level, educational inequalities in smoking are produced primarily by differences in smoking initiation—whether someone ever smokes regularly—rather than quitting (Maralani, 2013). Smoking initiation, however, occurs early in life. Nearly all adult smokers started smoking regularly before age 20, often in mid-adolescence (Chassin et al., 1996; Chen and Kandel, 1995; Lanz, 2003). Among adults who smoke daily, 71% had smoked daily by age 18 (Elders et al., 1994). Thus, the mechanisms linking education and smoking in adulthood have been operating from a much earlier point in the life course. Smoking regularly begins before many of the key educational transitions, such as high school graduation, college entry, and college completion, which serve as natural breaking points in the path through school. Even advanced statistical methods that adjust for unmeasured factors do not address the basic problem that, from a life course perspective, completed education generally comes after the transition to regular smoking.

This issue of timing underlying the relationship between education and smoking in adulthood is important not just conceptually and methodologically but also theoretically. The existing literature identifies many potential mechanisms that might link education and smoking; however, these are described as operating in adulthood (Cutler and Lleras-Muney, 2010; Link, 2008; Ross and Wu, 1995). But if the causal links between smoking and education in adulthood are in fact explained by characteristics and choices made in adolescence, then our existing theoretical framework must be reformulated to account for the links across the life course between characteristics in adolescence and smoking in adulthood. To give a concrete example, if adults with a college degree are less likely to smoke because they have better analytical or self-efficacy skills, or higher social integration, then they must have acquired these skills and resources in early adolescence, prior to modal ages of smoking initiation. The college degree may serve as a proxy for having gained these resources at an earlier point in school, but the college schooling itself did not provide the relevant resources. This is the theoretical and empirical problem that remains unexamined in the current literature.

This study extends the existing literature on the well-documented association between education and smoking on three fronts. The first is to refocus the theoretical discussion of the potential mechanisms linking education and smoking on adolescence rather than adulthood. The second is to estimate an empirical model of the relationship between education and smoking that accounts for the appropriate timing of the theoretically relevant mechanisms across the life course. The approach uses personal, family, and school-related characteristics of individuals when they were in 7–9th grade to predict whether they smoked regularly as adults. I control for a large number of potentially confounding factors such as psychosocial characteristics, family background, health characteristics, and future expectations, all measured *before* the transition to smoking regularly. The third contribution is to formulate a joint model of smoking and completed education in adulthood that considers the bundling of these outcomes, and how their joint distribution relates to personal, family, school, and smoking-related characteristics in adolescence, net of future expectations.

2. Background

The question of whether education has a causal effect on smoking has been primarily debated in the economics literature. Of central concern has been the issue of whether unobserved traits such as time preferences (how much one values her well-being in the present versus the future) or future expectations determine both education and smoking status. Farrell and Fuchs (1982) proposed this as the primary explanation for the observed association and showed that years of school completed predicted smoking status at age 17, well before that education was actually acquired. Subsequently, numerous studies have used a variety of statistical approaches to address the potential confounding of education, smoking, and time preferences. Some studies identify the causal effect of education on smoking by using the Vietnam draft or differences in graduation requirements and college openings to instrument education (de Walque, 2007; Grimard and Parent, 2007; Kenkel et al., 2006; Currie and Moretti, 2003). Others have used repeated observations on the same individual to net out unobserved characteristics (de Walque, 2010) or a control group method that matches individuals on age, education and enrollment status and compares these groups to counterparts with the same set of statuses, but born one year later (Tenn et al., 2010). All these empirical approaches but one (Tenn et al., 2010) find support for a causal effect of education on smoking.[1] By focusing on education in adulthood, however, these causal estimates can only describe the effect of smoking on quitting, rather than explaining the emergence of educational inequalities in smoking.

If education has a causal effect on smoking, it would operate through two potential mechanisms: initiation and quitting. These two mechanisms operate in different parts of the life course and suggest distinct conceptualizations of the relationship between education and smoking. Educational experiences could cause an individual to never smoke regularly (initiation). In this case, the mechanisms linking education and smoking would operate in adolescence, before the traditional ages at which

[1] Gilman et al., 2008 use sibling fixed effects on a small regional sample (518 participants representing 243 families) and find that the association between education and smoking is attenuated. Their estimates, however, have large standard errors, making the results difficult to interpret conclusively.

education is completed. Alternatively, more education could cause an individual who smokes to quit smoking. This mechanism operates across adulthood and is likely to come after school completion. Depending on their relative contribution to creating educational inequalities in smoking, these mechanisms point us to different parts of the life course for explaining and addressing educational disparities in smoking.

The existing evidence suggests that differences in initiation play a larger role in explaining educational disparities in adult smoking than differences in quitting. Although adults with more education are more likely to quit smoking (de Walque, 2010, 2007; Sander, 1995b), at the population level, differences in quitting play a small and diminishing role in explaining educational inequalities in adult smoking. First, educational disparities in never smoking (initiation) are large and have increased over time (Maralani, 2013; CDC, 1994; Pierce et al., 1989). Second, the portion of the gradient explained by quitting is itself a function of educational differences in initiation. As fewer people ever smoke, differences in quitting, no matter how large, apply to a shrinking part of the population. For American men, differences in initiation have explained nearly all the educational gap in adult smoking starting with the 1940–1949 birth cohort, and for women, starting with the 1950–1959 birth cohort (Maralani, 2013). The role of initiation rather than quitting in explaining educational inequalities in adult smoking means that these disparities are tethered to experiences early in life, rather than produced by the effect of education on smoking decisions in adulthood.

The relative role of initiation versus quitting in explaining educational gradients in smoking has important theoretical implications for understanding the causal links between education and smoking. Prevailing theoretical perspectives on why educational gradients in smoking exist argue that those with more schooling have important skills and resources that help them secure or produce better health (Cutler and Lleras-Muney, 2010; Link, 2008; Grossman, 2006; Mirowsky and Ross, 2003; Link and Phelan, 1995; Ross and Wu, 1995). Numerous mechanisms have been proposed, including having more money, power, prestige, and health specific knowledge; having better social networks and integration; and being more skilled in conceptual thinking, learning, and translating intentions into actions (Cutler and Lleras-Muney, 2010; Link, 2008). These theoretical perspectives, however, assume that individuals acquire their education prior to their health status or behavior. For behaviors such as smoking, this is not the case. Thus, although educational disparities in smoking are an undeniable marker of the social patterning of health inequality, our existing theoretical explanations need refinement in the case of smoking.

If education provides these health-producing skills and resources, it would have to do so in the teenage years in order to affect the transition to regular smoking. For example, resources such as better social networks and social integration would have to be present in the teenage years and would describe the friends one had in adolescence and how connected one felt as a youth to her family, friends, and teachers. Similarly, if more education provides better conceptual, analytical, or self-efficacy skills, it would have to do so in early adolescence prior to the modal ages of starting to smoke regularly. Finally, the theories and mechanisms proposed describe the attributes of individuals, but given that the transition to regular smoking is rooted in adolescence, we must also consider whether the relevant knowledge, skills, and networks are better thought of as attributes of *families*, rather than only individuals. This suggests the need to measure the characteristics of both individuals and their families in adolescence to see if these explain the relationship between education and smoking in adulthood.

The current analysis is rooted in the population health literature and seeks to contribute to our understanding of persistent educational inequalities in smoking. The literature on social gradients in smoking is large and crosses many disciplines. It can be broadly divided into those who study smoking in adolescence and those who study it in adulthood, although some studies also consider smoking trajectories from adolescence into adulthood (Pampel, 2009; Van Den Bree et al., 2004; Chassin et al., 1996; Chen and Kandel, 1995). Those who study the topic in adolescence focus on numerous psychosocial factors, including engagement in prosocial activities, family functioning, school attachment, personality, psychological health, social networks, neighborhood disadvantage, religiosity, and other substance use (see U.S. Department of Health and Human Services, 2012 and Van Den Bree et al., 2004 for detailed reviews). This literature examines smoking behavior at early ages and with a fine lens, distinguishing between smoking experimentation, smoking progression, discontinuation of experimental smoking, and progression to smoking regularly.

Those who study smoking in adulthood abstract from early life experiences, focusing instead on current smoking or smoking cessation. These studies treat education as something that is completed early in life, and thus prior to adulthood, and consistently show dramatic inequalities in smoking by education (de Walque, 2010; Reid et al., 2010; Pampel, 2009, 2005; de Walque, 2007; Grimard and Parent, 2007; Kenkel et al., 2006; Cutler and Glaeser, 2005; Currie and Moretti, 2003; Gilpin and Pierce, 2002; Smith and Fiore, 1999; Garfinkle, 1997; Breslau and Peterson, 1996; Escobedo and Peddicord, 1996; Sander, 1995a,b; Fiore et al., 1989; Pierce et al., 1989). Some of these studies focus on estimating the causal effect of education on smoking, while others focus more descriptively on documenting educational inequalities in smoking. The current study uses longitudinal data to bridge these different approaches and show that educational gradients in adult smoking are rooted in early life and school experiences.

3. Potential mechanisms between schooling and smoking status

The path through formal schooling is a complex and multidimensional process that occurs over many years and domains. Educational attainment involves various curricular offerings and choices, peer contexts, adult role models, institutional

policies, learning skills such as reading, writing, and analytical thinking, and making key transitions. These components inform the process of schooling, and combine with individuals' personal, family, and school characteristics and choices to result in—or rather, accrete to—a final educational status. Total years of education is the coarse summary of this whole process. To understand better the mechanisms relating education and smoking, we have to disaggregate education into a set of detailed characteristics measured in adolescence. This detailed approach allows a way of mapping the theoretical mechanisms proposed between education and health to specific components of personal and family characteristics and school-related experiences that might produce the robust correlation between education and smoking in adulthood. The analyses that follow operationalize these mechanisms and measure these characteristics before the transition to regular smoking.

3.1. Information

Schools provide health information directly by providing classes with health-related content. As institutions, schools also set policies that convey a message regarding health behavior. For example, although most schools ban alcohol, tobacco, and drug use by students, they differ in how severely they punish students when they break these rules, and whether they allow faculty and staff to smoke on campus. Schools with more severe punishments for smoking or that ban faculty and staff smoking on campus send students a stronger negative message about smoking than more lenient schools.

3.2. Analytical skills

Schools teach analytical skills such as numeracy, literacy, and reasoning. Classes such as algebra and English literature may spark our imagination and nurture a taste for learning, but they also teach concrete skills such as computing the area of a room, reading critically, or writing persuasively. It is in this sense that schooling makes one "smarter." Research shows that differences in standardized test scores are in part explained by differences in schooling (Winship and Korenman, 1997). Similarly, increases in average IQ over time are related to changes in the type of skills that are emphasized in schools (Flynn, 2007). Thus, one would expect that those who take more math or science classes, net of background characteristics and endowment, gain more numeracy and reasoning skills. These analytical skills may in turn help individuals make better health-related choices.

3.3. Social networks

Schooling brings adolescents into contact with other adolescents. Peers form an important part of adolescents' school and health experiences, providing both positive and negative influences in both areas. On the one hand, girls whose friends take more advanced math classes are more likely to take these advanced classes themselves (Riegle-Crumb et al., 2006). On the other hand, having a friend who smokes is a strong predictor of smoking initiation (Alexander et al., 2001).

3.4. Non-cognitive skills

A more difficult to measure concept is that of non-cognitive skills, ("soft skills"), including organizational and time management skills, working well in groups or with others, and self-efficacy (Duncan and Dunifon, 1998; Bowles and Gintis, 2000). Non-cognitive skills are difficult to disentangle from attributes such as motivation and tenacity, which are likely both a cause and a consequence of schooling. Nonetheless, non-cognitive skills are associated with schooling and represent a dimension of skills that is distinct from cognitive or reasoning skills. Participating in organized team sports or student government, for example, might teach interpersonal and organization skills. Group projects or participating in the school band might teach teamwork and cooperation. These experiences might help individuals feel more socially connected, be more persistent, or more able to achieve the goals they set for themselves. These same skills might also help people make better health-related choices.

3.5. Future expectations

Another difficult to measure but important mechanism is how individuals think about the present versus the future. Here too it is likely that schooling and forward thinking cause one another. On the one hand, one's parents might instill or endow educational aspirations. On the other hand, a teacher or early success in school might nurture this orientation (now a school mechanism). Schooling certainly teaches delayed gratification and success in school requires a healthy dose of such deferment. Decisions about deferring experiences from the present to the future can have important health consequences. Since few take up smoking for the first time after age 20, the longer smoking is delayed in adolescence, the lower its likelihood in adulthood. Future expectations might cause someone both to pursue more education and not to smoke. This would induce a correlation between these statuses in adulthood. Thus, it is important to measure these expectations early in life and prior to the start of smoking. It is also possible that the effect of expectations or time horizons differ by domain. Future expectations

regarding education may differ from those relating to health or well-being. This possibility has not been tested directly in the existing literature.

3.6. Joint determination

It is also possible that education and smoking status in adulthood are shaped jointly by school-related experiences in adolescence. If the mechanisms described above influence decisions about both smoking and school investment or continuation, then these early school-related mechanisms might inform the joint distribution of education and smoking in adulthood. Alternatively, the correlation between smoking and education in adulthood might be produced by characteristics unrelated to actual school experiences, such as personality or endowed (rather than school-produced) preferences or one's future expectations (Farrell and Fuchs, 1982). If the same set of future expectations determines *both* one's education and smoking status in adulthood, then this would produce a correlation between these statuses among adults.

The relationship between schooling and smoking might also be bi-directional, with early schooling informing early smoking decisions, and early smoking decisions, in turn, informing later school choices. This would be consistent with the existing literature on the dual relationship between health and economic status (Smith, 1999). The mechanisms for the effect of early smoking on later schooling may be either biological or social. For example, nicotine withdrawal from not smoking at school might make concentrating in school more difficult or encourage absenteeism or truancy (Jacobsen et al., 2005). Or, because smoking is stigmatized, adolescents who smoke might accumulate less social capital as they proceed through school. Teachers, successful peers, or the parents of these peers may treat young smokers differently. If their social, academic, or romantic networks suffer, this might in turn lead to completing fewer years of schooling. Although testing the potential mechanisms running from smoking to education is beyond the scope of this paper, the larger theoretical point is that we should also consider the possibility that education and smoking in adulthood might be bi-directional, rather than jointly determined, based on mechanisms operating in adolescence.

4. Research design

4.1. Analytical approach

The analyses describe the relationship between education and smoking from adolescence to adulthood. First, I demonstrate the links between smoking initiation and later educational attainment by showing the age trajectories of smoking initiation by completed education. Next, I consider the relationship between the personal, family, and school-related characteristics of adolescents who are not smokers in 7–9th grade and the probability of being a current smoker in adulthood. Finally, I examine whether smoking and education in adulthood are jointly determined by individuals' characteristics in adolescence. Taken together, these three parts extend our understanding of the mechanisms linking education and smoking, and establish more precisely how these connections develop over the life course.

4.2. Data

The analyses use the National Longitudinal Study of Adolescent Health (Add Health), a nationally representative panel data set designed to assess the health behaviors of adolescents. The Add Health offers rich detail on family and personal characteristics, school experiences, friendship networks, health behaviors, and work experiences. The analyses use the Wave I and Wave IV longitudinal data along with the transcript and school administrator data. Wave I was fielded in 1994 and 1995 and Wave IV was fielded in 2008 and 2009. The match across the first and fourth waves is about 76%. The data include sampling weights to correct for attrition, and analyses show the longitudinal data are quite representative when weighted (Chantala et al., 2004). The Wave I measures provide data on background characteristics and early (pre-smoking) school-related experiences and the Wave IV data provide educational and smoking statuses in adulthood. Add Health collected information on the high school courses taken by respondents in 2001–2002, as part of the Wave III data collection effort. These course-taking data include official high school transcripts for most Wave III respondents. Table 1 shows summary statistics for the variables included in the analyses.

4.3. Methods

The analyses use the following statistical models. First, I describe age trajectories of smoking initiation using a discrete-time hazard model estimated with a logistic regression (Allison, 1984). Second, I predict the likelihood of being a regular smoker in adulthood using a logistic model. Finally, I describe the joint distribution of smoking and education in adulthood using a multinomial model. Each model is described in more detail in the text below.

Using the guidelines provided by the Add Health (Chantala, 2006; Chantala and Tabor, 2010), all models adjust for the complex sample design and nested nature of the data, using the survey commands in Stata 12.1. All analyses specify region as a stratum variable and schools as the primary sampling unit, and use the grand sample weights from Wave I and Wave IV, as appropriate. The statistical models are population average models rather than multilevel models. When the design effects are properly controlled, both statistical models are appropriate approaches for the Add Health data (Chantala, 2006).

Table 1
Sample summary in Wave I, Add Health 7–9th graders ($N = 3458$).

	Mean	95% CI	
Male	0.47	0.46	0.49
Race/ethnicity			
Black	0.13	0.09	0.17
Latino	0.10	0.07	0.12
White	0.71	0.65	0.77
Asian	0.03	0.02	0.05
Other	0.01	0.01	0.02
Age (years)	13.88	13.74	14.00
Self-Report health (1 = excellent or very good)	0.71	0.69	0.73
CES-D Depression Scale (0–57)	14.17	13.91	14.42
Protective factor scale (8–40)	33.34	33.09	33.60
Parental education			
>12 years	0.11	0.08	0.13
12 years	0.35	0.32	0.37
13–15 years	0.21	0.19	0.23
⩾16 years	0.34	0.30	0.38
Parent expectation for college completion (1 = yes)	0.71	0.69	0.74
Female-headed household	0.22	0.20	0.25
Parent smokes	0.67	0.65	0.69
Has friend who smokes	0.29	0.26	0.32
Has friend who smokes marijuana	0.19	0.17	0.22
Ever held back a grade	0.15	0.13	0.18
Ever skipped school without excuse	0.13	0.11	0.15
Future expectations			
Very likely to live to age 35	0.91	0.89	0.92
Very unlikely to die by age 21	0.89	0.87	0.90
Very unlikely to get HIV	0.91	0.89	0.92
Wants to attend college	0.90	0.88	0.91
Expects to attend college	0.82	0.80	0.84
Strong Punishment for 1st Smk. Offense	0.48	0.37	0.59
Strong Punishment for 2nd Smk. Offense	0.81	0.73	0.88
Fac./Staff Smoking Banned on Campus	0.77	0.67	0.87
Grade 9 Math: Lower than Algebra I	0.32	0.28	0.36
Algebra I	0.48	0.44	0.52
Higher than Algebra I	0.20	0.17	0.23
Grade 9 Science: Lower than Earth Science	0.13	0.10	0.16
Earth Science	0.51	0.45	0.58
Higher than Earth Science	0.36	0.30	0.42
Regular Smoker at Wave IV	0.28	0.25	0.31
Has less than college degree and non-smoker at Wave IV	0.43	0.40	0.46
Has less than college degree and smoker at Wave IV	0.23	0.21	0.26
Has college degree and non-smoker at Wave IV	0.29	0.26	0.32
Has college degree and smoker at Wave IV	0.05	0.04	0.06
Regular Smoker by age 16	0.22	0.20	0.24

Notes: Means and proportions are weighted to correct for sample design and attrition.

4.4. Dependent variables

The analysis has three parts, each with a different dependent variable. The first part examines age-patterns of smoking initiation. Here, the dependent variable is the probability that the respondent first started smoking regularly at each age from 10 to 29, conditional on having not smoked regularly prior to that age. These analyses use all respondents from Wave I and Wave IV with valid data on education and smoking histories ($N = 13,329$).

Next, I examine the relationship between personal and family characteristics, future expectations, and school experiences, all measured in early adolescence (Wave I), and the probability of being a current smoker as an adult (age 25–29 in Wave IV). In this part, I limit the analyses to those enrolled in 7–9th grade at Wave I with valid information on the covariates ($N = 3458$). About 90% of these respondents were age 13, 14, or 15 at Wave I, and the remaining 10% nearly equally divided between age 12 and 16.

I exclude respondents who had already started smoking regularly by 9th grade (about 8% of these 7–9th graders) from these analyses.[2] This exclusion guarantees the correct life course ordering of the background, school-related, and time

[2] The analyses omit 11% of 15 year-olds ($N = 125$) and 15% of 16 year-olds ($N = 31$) who are current smokers in 7–9th grade. The longitudinal nature of the data, however, means that we observe the future smoking behavior of a large number of children ages 12–14 at Wave 1 as they age ($N = 2,274$). Thus, the analysis has substantial information on the characteristics and behavior of youth at ages 15 and 16, despite the unequal age censoring of respondents who smoke at Wave I.

horizon variables to the respondents' later smoking status but comes at the cost of dropping a group of very young smokers who are likely to be negatively selected on many characteristics, including their future education. This sample selection has two implications. First, the results are only generalizable to adolescents who were not very early smokers. Second, it seems clear that for a subset of adult smokers, the relevant school experiences and future expectations reach as far back as elementary school. I discuss the implications of this in the conclusion. I have also confirmed that the substantive results are quite similar if these respondents are included in the analysis—although the interpretation of the results is then compromised.

Respondents are classified as current smokers if they (a) have ever smoked at least one cigarette a day for 30 consecutive days and (b) smoked at least 10 of the past 30 days. I set the threshold for current smoking at a level less than daily because the existing literature shows that adolescents are nicotine dependent at much lower thresholds (de Leeuw et al., 2009; DiFranza et al., 2000). Studies have identified weekly, rather than daily smoking as "regular smoking" (Chassin et al., 1996). Weekly smoking suggests a number of days on the order of 8–12 per month as the threshold for being a current smoker (versus an occasional smoker). I have selected 10 days as the cutoff, but the results are substantively similar if this threshold is set at 5, 15, 20, or 25 days as well. Respondents also report the age at which they first smoked for 30 consecutive days. I use this age as the age of starting to smoke regularly.

In the final set of analyses, I consider the joint distribution of smoking and education. For this part, I combine respondents' smoking status at Wave IV with a binary measure of whether they had completed college by Wave IV. I also tried several alternative measures of education in adulthood, including education and smoking status measured at Wave III, and a binary measure of college entry rather than college completion from Wave IV (results not shown). The results are quite consistent across different measures of education in adulthood.

4.5. Independent variables

The analyses include measures of personal and family characteristics that have been shown in the existing literature to be important correlates of schooling and smoking. Family background variables include parents' education, whether either parent has ever smoked, whether respondents lived in a female-headed household, and respondents' report of how disappointed their parents would be if they did not complete college.[3] I also tested additional measures of socioeconomic status in adolescence including family income, whether the parent worked full-time, public assistance receipt, and measures of neighborhood quality. These measures are omitted in the results reported below because they did not predict smoking in adulthood and require dropping an additional 21% of the sample. Adding these variables to the analyses described below does not change any of the substantive results, despite the substantial drop in sample size. Personal characteristics include age, race/ethnicity, gender, whether the respondent was ever held back a grade, and whether the respondent had ever skipped a day of school without an excuse.

Measures of health include a self-reported summary measure of health (general health status) as well as the score on a standardized depression scale (CES-D).[4] Higher numbers indicate more symptoms of depression. The analyses also include the score on a set of questions measuring protective factors such as attachment to one's family, teachers, and friends. Here, higher numbers indicate having more protective factors.[5] I include a measure for whether respondents had at least one best friend who smoked at Wave I (the sample is constrained such that none of the respondents themselves smoked at Wave I) and whether they had at least one best friend who used marijuana.[6] Because cognitive skills and schooling are closely tied, the analyses include a measure of scholastic aptitude and verbal skills as summarized by respondents' scores on the Peabody Vocabulary Test (PVT). The results do not change if PVT is excluded from the models.

The analyses measure expectations directly, rather than sweeping these away by an instrument or differencing approach. The data include several measures of future expectations. Some of these tap educational expectations and aspirations while others proxy health and mortality expectations. There are two measures of respondents' own educational aspirations. One asks how much the respondent would like to go to college. The other asks how likely it is that the respondent will attend college. Health and mortality expectations are captured by binary measures of whether the respondent reported each of the following statements to be very likely or quite certain: "You will live to age 35;" "You will be killed by age 21" (reverse coded); and "You will get HIV or AIDS" (reverse coded). Affirmative responses indicate more positive expectations or longer time horizons.

Turning to school experiences, the analyses distinguish between features of schools as institutions, the content of schooling such as coursework, and extracurricular activities. The analyses include measures for three school policies: How strongly the respondent's school (when she or he was in 7–9th grade) punished the first and second smoking offenses, and whether the school prohibited faculty and staff from smoking on school grounds.

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[3] The parent is also asked this question directly. Results are not sensitive to which measure is used.

[4] These CES-D variables have a Cronbach's alpha of 0.86.

[5] The questions are: How much do you feel that adults care about you? How much do you feel that your teachers care about you? How much do you feel that your parents care about you? How much do you feel that your friends care about you? How much do you feel that people in your family understand you? How much do you feel that you want to leave home (reverse coded)? How much do you feel that you and your family have fun together? How much do you feel that your family pays attention to you? These variables have a Cronbach's alpha of 0.98.

[6] The questions are: Of your 3 best friends how many smoke at least 1 cigarette a day? Of your 3 best friends, how many use marijuana at least once a month?

The analyses also measure courses that reflect numeracy, reasoning, and analytical skills. These are the skills that might help with health-related learning and information processing (Cutler and Lleras-Muney, 2010). One would expect that those who take higher level math or science classes, net of background characteristics, gain more numeracy and reasoning skills. These analytical skills may in turn help individuals make better health-related choices (Goldman and Smith, 2002). Analytic skills are measured by the math and science classes respondents took in 9th grade. For math, the modal level is taking algebra I. I divide respondents into three groups: those who took a lower level than algebra I in 9th grade, those who took algebra I, and those who took a more advanced math class in 9th grade. For science, I divide students by whether they took less than earth science, earth science, or a more advanced science class in 9th grade (i.e., biology, chemistry, or physics). I constructed these measures using respondents' official high school transcripts, which list all the courses taken between grades 9 and 12.

I tried two approaches to measuring non-cognitive skills. First, I measured non-cognitive skills by participation in extracurricular activities such as academic clubs, sports, and drama, music, or art, which might teach interpersonal and organizational skills, teamwork, and cooperation. Neither the number of extracurricular activities nor the type (categorized as academic, sports, or arts) predicted smoking status in adulthood. Alternatively, I tried measures of how well respondents got along with teachers and other students. None of these measures of non-cognitive skills had a significant association with smoking in adulthood, and these require using an even smaller subset of the data. Thus, non-cognitive skills are excluded from the results reported below (results available from author).

In the final set of analyses, I use a respondent's smoking status at age 16 as an independent variable predicting the joint distribution of smoking and education in adulthood. In choosing age 16 as the cutoff I aim to select an age that is early enough to precede traditional ages of school leaving yet late enough to capture the modal ages of smoking initiation. Among those who had smoked regularly in the Add Health, about 60% had started smoking by age 16. I use whether the respondent had started smoking regularly by age 16 as a predictor of both smoking and completed education later in life. I discuss this variable, and what it may represent or proxy, in more detail below.

5. Results

5.1. A life course perspective on smoking and education

Educational inequalities in smoking regularly are distinctly present in adolescence, long before that education is actually acquired. Fig. 1 shows the discrete-time hazard of starting to smoke regularly from age 10 to 29, by the final level of education obtained by Add Health respondents at Wave IV (N = 180,812 person years).[7] The model only controls for age, gender, and race-ethnicity, and is estimated separately for each education group (coefficients not shown). The graph shows the predicted probability of starting to smoke regularly at each age for four education groups: (1) those who do not finish high school; (3) those with only a high school degree; (2) those with some college completed; and (3) those with a college degree.

The results show a set of nested curves that all share the same general age pattern. For all four education groups, the probability of starting to smoke regularly rises in the early teens, peaks in mid to late adolescence, and then declines precipitously after age 18. These age patterns, however, have a distinct gradient by completed education, and all of the meaningful differences by education occur at ages 12–18, rather than in adulthood. Across adolescence, respondents who do not finish high school have the highest probability of starting to smoke regularly. These probabilities rise sharply from age 12 to 16, with peaks at age 16 and 18. This age pattern reflects both the developmental stages of adolescent maturation and institutional and legal constraints that limit opportunities for smoking among teenagers. Age 16 is the minimum age of school leaving in a sizable number (though not majority) of states in the country. Age 18 is the age at which one can buy cigarettes legally in nearly all states, and the modal age of college entry.

For respondents with only a high school degree, the probability of starting to smoke regularly follows a similar age pattern, again with peaks at ages 16 and 18. But compared to those who drop out of high school, high school graduates have much lower probabilities of starting to smoke regularly across their teenage years. This level, however, is systematically higher than observed for those who obtain some college schooling. Moreover, for those who enter college, the probability of smoking regularly does not peak at age 16, as it did for the two lower education groups. Instead, for this group, the probability peaks at age 18 only. Respondents who go on to complete college have the lowest probabilities of starting to smoke from age 12 to 18, and a much lower peak at age 18 than all the other education groups. By age 19, the age-specific probabilities of starting to smoke converge for all education groups, and by age 20, these probabilities approach zero.

Educational gradients in smoking begin extremely early in life. Those who go on to complete more education are much less likely to ever smoke regularly in adolescence, and thus, adulthood. These groups also display a two-year delay in when the probability of smoking initiation peaks, which is substantial from a public health perspective. For all education groups, the risk of taking up smoking converges by age 19, at the cusp of the transition to adulthood. This age pattern underscores the importance of understanding the relationship between education and smoking from a life course perspective. Differences in smoking by completed education are apparent as early as age 11 and 12, long before high school completion and the college years.

[7] Age is specified with a full set of single-year dummies.

5.2. Educational mechanisms and smoking status

The next set of analyses relates personal, family, peer, and school-related characteristics in adolescence to smoking status in adulthood. Table 2 shows the results from logistic regressions that predict the probability of being a current smoker in

Table 2
Logistic model of smoking regularly in adulthood (odds ratios shown), Add Health (N = 3,458 7–9th graders).

	2.1 Background	2.2 Future Expectations	2.3 School-related
V. good/excellent health	0.887	0.893	0.920
	[0.70, 1.12]	[0.70, 1.14]	[0.72, 1.17]
CES-D (depression)	1.018	1.015	1.016
	[1.00, 1.04]	[0.99, 1.04]	[0.99, 1.04]
Protective Factors Score	0.99	0.999	1.001
	[0.97, 1.01]	[0.98, 1.02]	[0.98, 1.03]
Parent Educ. (Ref. = 16 + yrs)			
Parent educ. <12 yrs	1.043	0.986	0.858
	[0.71, 1.53]	[0.66, 1.46]	[0.58, 1.27]
Parent educ. 12 yrs	1.278†	1.231	1.122
	[0.99, 1.65]	[0.94, 1.61]	[0.86, 1.47]
Parent educ. 13–15 yrs	1.191	1.166	1.094
	[0.87, 1.63]	[0.85, 1.59]	[0.80, 1.50]
Parent expectation for college completion (1 = high)	1.034	1.068	1.085
	[0.82, 1.30]	[0.85, 1.35]	[0.86, 1.37]
Fem. Headed Household	1.323*	1.316*	1.310*
	[1.05, 1.67]	[1.03, 1.67]	[1.03, 1.66]
Parent has ever smoked	1.806*	1.807*	1.771*
	[1.49, 2.19]	[1.48, 2.20]	[1.45, 2.16]
Friend smokes	1.457*	1.452*	1.459*
	[1.13, 1.87]	[1.13, 1.86]	[1.14, 1.86]
Friend uses marijuana	1.267†	1.247	1.194
	[0.96, 1.67]	[0.95, 1.64]	[0.90, 1.58]
Ever held back a grade	1.166	1.095	1.072
	[0.86, 1.58]	[0.80, 1.50]	[0.77, 1.49]
Ever skip school	1.247	1.242	1.221
	[0.95, 1.63]	[0.95, 1.63]	[0.93, 1.60]
PVT score (Ref.=middle third)			
PVT bottom third	0.917	0.886	0.832
	[0.66, 1.28]	[0.63, 1.25]	[0.60, 1.16]
PVT top third	0.843	0.855	0.921
	[0.65, 1.09]	[0.66, 1.11]	[0.70, 1.21]
Very likely to live to age 35		0.787	0.787
		[0.58, 1.07]	[0.57, 1.08]
Very unlikely to die by age 21		0.610*	0.605*
		[0.42, 0.89]	[0.42, 0.88]
Very unlikely to get HIV		0.797	0.835
		[0.52, 1.23]	[0.54, 1.30]
Wants to attend college		0.806	0.812
		[0.54, 1.19]	[0.55, 1.21]
Expects will attend college		0.992	1.061
		[0.72, 1.36]	[0.78, 1.45]
Strong Punishment, 1st Smoking Offense			1.09
			[0.81, 1.47]
Strong Punishment, 2nd Smoking Offense			0.921
			[0.68, 1.25]
No Faculty/Staff Smoking on Campus			0.667*
			[0.49, 0.90]
Math in 9th grade (Ref. = higher than Algebra I)			
Lower than Algebra I			1.763*
			[1.20, 2.59]
Algebra I			1.594*
			[1.12, 2.28]
Science in 9th grade Ref. = higher than earth science			
Lower than earth science			1.13
			[0.77, 1.66]
Earth science			1.004
			[0.81, 1.25]

Notes: All models also control for sex, race/ethnicity and age. Results are weighted to correct for sample design and attrition. 95% confidence intervals shown in brackets.
* $p < 0.05$.
† $p < .10$.

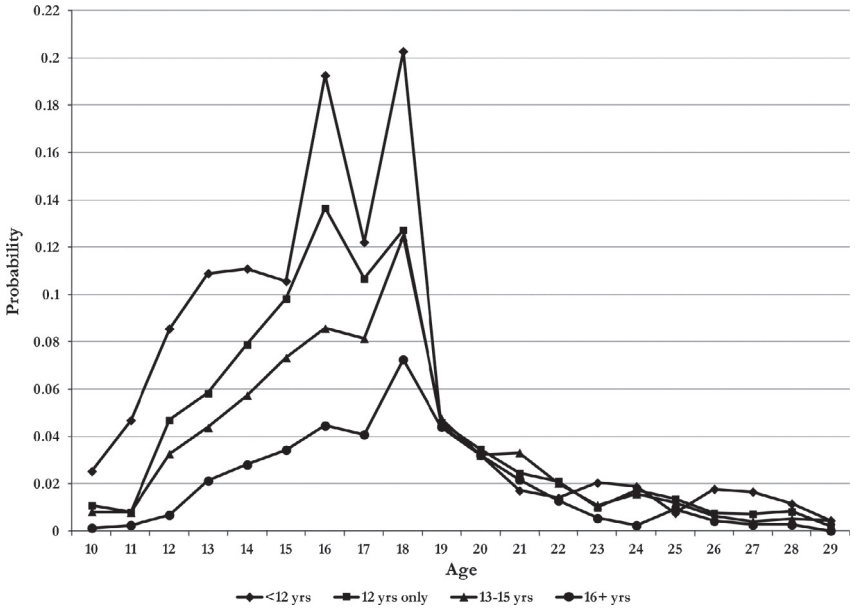

Fig. 1. Discrete time hazard of initiation of smoking regularly by education and age, Add Health (N = 180,812 person years). Notes: Analyses are weighted to correct for sample design and attrition. Model controls for age in single years, gender, race/ethnicity, and education level measured at Wave IV when most respondents were ages 25–29.

adulthood, using a set of detailed and theoretically relevant characteristics from adolescence. These regressions address three issues. First, they measure the mechanisms theorized to run from education to health in adolescence rather than adulthood, when these mechanisms should actually operate in order to affect the decision to start smoking regularly. Second, by explicitly measuring as many potential mechanisms as possible, the analyses leverage the exceptionally detailed variables available in the Add Health data to assess how these potential mechanisms work together. Third, the analyses use the longitudinal design of the data to follow a subset of Add Health respondents who had never smoked regularly from early adolescence (grades 7–9 at Wave I) to adulthood. The regressions predict the smoking status of these respondents in adulthood (ages 25–29) using their characteristics and statuses from adolescence.

The results shown in Model 2.1 reproduce the general findings established in the literature. Youth who lived in a female-headed household in early adolescence, a proxy for economic disadvantage, have higher odds of being current smokers in adulthood (odds ratio (OR) of 1.3). Having a parent who has ever smoked nearly doubles the odds of smoking in adulthood (OR of 1.8). Similarly, having at least one best friend who smoked cigarettes when respondents were in grades 7–9—and, by design, did not smoke themselves—multiplies the odds of smoking in adulthood by 1.5. Having at least one best friend who used marijuana in grades 7–9 increases the odds of smoking in adulthood by a factor of 1.3 ($p < .09$). Holding these personal, family, and peer characteristics constant, PVT scores are not significantly associated with adult smoking status. The point estimates of the other variables are in the expected direction. All subsequent models control for this set of personal, family, and peer characteristics.

Model 2.2 adds measures of future expectations. All the measures have point estimates in the expected direction and one of these is statistically significant. The odds of smoking in adulthood were about 40% lower for respondents who reported they were very unlikely to die by age 21 relative to those who were less certain about this mortality expectation as teenagers. This pattern is in line with economic theory that predicts that those with longer time horizons have more reason to invest in health than those with shorter ones. Although this mortality-related expectation predicts adult smoking, educational expectations do not. Net of a comprehensive set of covariates, aspirations and expectations specific to college going do not predict adult smoking.

Model 2.3 adds measures of school-related experiences. Although the school's severity of punishment for smoking offenses does not predict adult smoking, school policies regarding faculty and staff smoking on campus predict respondents' smoking status as an adult. Those who attended schools in 7–9th grade that banned faculty and staff from smoking on campus had 33% lower odds of smoking in adulthood than those attending schools without this restriction. Turning to coursework and analytical skills, relative to those who took more advanced math in 9th grade, respondents who took algebra I or a lower level of math had significantly higher odds of smoking in adulthood. The results for science classes are not significant.

The results in Table 2 show empirical support for many of the mechanisms theorized to run from education to smoking, and do so in adolescence, at the point in the life course when these should be operating. Characteristics from adolescence describing the behavior of friends, future mortality expectations, institutional policies of schools, and math coursework are all significant predictors of smoking status at ages 25–29. Controlling for a detailed and usually unobserved set of

personal and family characteristics that likely predict both schooling and health, these education-related mechanisms in 7–9th grade are significantly associated with smoking in adulthood.

These results, however, raise three important questions that cannot be answered with the analyses summarized in Table 2. First, do these mechanisms predict education as well, and thus, jointly determine completed education and smoking in adulthood? Second, can we distinguish if taking advanced math classes is a proxy for analytical skills that could be used for making better health choices, or instead a proxy for other unobserved characteristics such as non-cognitive skills that jointly determine education and smoking in adulthood? Third, given that the education-related expectations did not predict later smoking status, do the health-related future expectations predict later educational attainment? The results in Table 3 address these questions.

5.3. Adult education and smoking as bundled statuses

A different way of thinking about the links between education and smoking in adulthood is to conceptualize these as jointly determined, rather than assuming that the mechanisms run from education-related characteristics to smoking status. Conceptually, this bundling might happen in one of two ways: these statuses in adulthood may be jointly determined by a set of characteristics from childhood and adolescence (Farrell and Fuchs, 1982) or, like other aspects of socioeconomic status and health, these relationships may be bi-directional (Smith, 1999), with early educational characteristics informing early smoking trajectories and early smoking trajectories, in turn, informing later school transitions. The final set of analyses examines these possibilities.

Table 3 shows results from a set of multinomial models that specifies education and smoking as bundled outcomes. Respondents are grouped in one of four categories measured in adulthood: (1) having less than college completed and being a non-smoker (43% of sample); (2) having less than college completed and being a current smoker (23% of sample); (3) having a college degree and being a non-smoker (29% of sample); and (4) having a college degree and being a current smoker (5% of sample). This combined education-smoking status in adulthood is regressed on the same set of characteristics from adolescence described above for the same subsample of respondents. I use the "no college degree and non-smoking" group as the reference group. To condense the results, I omit the coefficients for PVT, ever skipping school, and the severity of punishment, although these covariates are controlled in the models. As in Table 2, these coefficients are not statistically significant in the results summarized in Table 3.

Table 3
Multinomial model of smoking and education in adulthood (odds ratios shown), Add Health (N = 3458 7–9th graders).

Reference category: <16 yrs, Non-Smoker	4.1 <16 yrs Smoker	4.1 ⩾16 yrs Non-Smoker	4.1 ⩾16 yrs Smoker	4.2 <16 yrs Smoker	4.2 ⩾16 yrs Non-Smoker	4.2 ⩾16 yrs Smoker
V. good/excellent health	1.067	1.707*	1.13	1.098	1.771*	1.133
CES-D (depression)	1.01	1.01	1.084*	1.002	1.011	1.082*
Protective factors score	0.997	1.013	1.062	1.014	1.007	1.068†
Parent educ. (Ref. = 16 + yrs) Parent educ. <12 yrs	0.655†	0.135*	0.124*	0.719	0.123*	0.132*
Parent educ. 12 yrs	0.918	0.370*	0.326*	0.909	0.374*	0.318*
Parent educ. 13–15 yrs	0.925	0.403*	0.322*	0.919	0.400*	0.318*
Parent expectation for college (1 = high)	1.072	1.10	1.517	1.077	1.061	1.554
Female-headed household	1.284*	1.031	1.543	1.23	1.079	1.538
Parent has ever smoked	1.879*	1.128	1.859*	1.714*	1.154	1.802†
Friend smokes	1.557*	0.787	0.610†	1.212	0.841	0.559*
Friend uses marijuana	1.028	0.867	1.950*	0.845	0.931	1.755†
Ever held back a grade	0.981	0.332*	0.327*	0.962	0.316*	0.328*
Very likely live to age 35	0.729†	0.989	1.964	0.742	1.003	1.955
Very unlikely die by 21	0.614*	1.185	0.814	0.606*	1.202	0.823
Very unlikely to get HIV	0.798	1.187	1.369	0.806	1.195	1.418
Wants to attend college	0.871	1.991†	1.228	0.994	2.186*	1.249
Expects will attend college	1.068	1.407	2.206	1.028	1.371	2.274
No faculty/staff smoking on campus	0.697*	1.303	0.865	0.719†	1.332	0.889
Math in 9th grade (Ref. = above algebra I)						
Below Algebra I	1.123	0.100*	0.185*	0.979	0.100*	0.174*
Algebra I	1.278	0.379*	0.429*	1.217	0.385*	0.415*
Science in 9th grade (Ref. = above earth science)						
Below earth science	1.051	0.447*	0.362*	1.092	0.457*	0.349*
Earth science	0.896	0.737*	0.797	0.912	0.746†	0.791
Smoke regularly by age 16				5.818*	0.518*	2.451*

Notes: All models also control for sex, race/ethnicity, age, ever skipped school, PVT, and severity of first and second punishment for smoking offence. Estimates are adjusted for sample design and attrition.

* $p < 0.05$.

† $p < .10$.

The first column in Table 3 describes the contrast between respondents in the "no college degree and smoking" group versus those in the "no college degree and non-smoking" group. This contrast compares individuals who are the same in terms of education (no college completed) but differ in smoking status. Respondents who lived in a female-headed household as teenagers, had a parent who smoked, or had a friend who smoked when they were in grades 7–9 had significantly higher odds of being in the "no college degree and smoking" group as adults versus the "no college degree and non-smoking" group. Those who, as teenagers, said they were very likely to live to age 35 ($p < .097$) or very unlikely to die by age 21 had lower odds of being in the smoking group in adulthood. Again, the educational expectations are not significantly associated with being in the smoking group. Those who attended schools in 7–9th grade that banned faculty and staff smoking on campus also had lower odds of being in the "no college degree and smoking" group versus the "no college degree and non-smoking" group. Neither math nor science coursework is significant for this contrast.

The second column shows the contrast between respondents with a college degree who did not smoke and those with less education completed who also did not smoke. This contrast compares two groups that are the same in terms of smoking (both non-smoking) but differ in educational attainment. For this contrast, nearly all of the education-related mechanisms are significant and none of the smoking-related ones are significant. Being in very good or excellent health, having a parent with a college degree, not held back a grade, and taking advanced math or science at 9th grade, predict higher odds of being in the "college degree and non-smoking" group versus the "no college degree and non-smoking" group. In contrast, having a parent who smoked or a friend who smoked is not significantly associated with the odds of being in the "college degree and non-smoking" group. Health-related expectations are also not significant predictors of being in the "college degree and non-smoking" group versus the "no college degree and non-smoking group." Instead, educational aspirations for college going significantly predict being in the "college degree and non-smoking" group.

Column three shows the contrast between respondents with college degrees who were current smokers in adulthood and those without a college degree who were not smokers. Here, both education-related and health-related mechanisms are significant. Those with a parent who had a college degree, not held back a grade, and taking advanced math in 9th grade, had higher odds of being in the "college degree and smoking" group versus the "no college degree and non-smoking" group. Those below grade level in science were also less likely to be in this college-degree smoking group, relative to those who took advanced science. Higher depression scores in adolescence, a well-established mechanism for smoking (Van Den Bree et al., 2004) also predict higher odds of being in the highly educated-smoking category as an adult. Having a parent who smoked, a friend who smoked, or a friend who used marijuana when the respondent was a teenager, also predicts higher odds of being in this high education and smoking category relative to the lower education and non-smoking baseline category. These characteristics may either proxy youths' own unobserved preferences or capture negative peer and parent effects. The results presented cannot distinguish between these two possibilities.

To summarize the results from this joint model of education and smoking in adulthood, for respondents without a college degree, smoking-related exposure in adolescence (parent smoking or friend smoking) predicts adult smoking status. Similarly, health-related but not educated-related expectations also predict adult smoking status. On the institutional side, the smoking policies of schools are associated with adult smoking status. In contrast, when comparing groups with the same smoking status but different educational levels, the health-related covariates are not significant. Instead, covariates such as parent's education and being ahead of grade level in math or science predict higher odds of being in the "college degree and non-smoking" group. Educational expectations also predict being in this group but health-related expectations do not. Being in good health, a well-established mechanism for more schooling (Case et al., 2005), predicts higher odds of being in the "college degree and non-smoking" group versus the "no college degree and non-smoking" group. When comparing groups across both smoking and educational status, a mix of these mechanisms is significant.[8]

Model 3.2 (shown in columns 3–6) adds a binary measure of whether the respondent had started smoking by age 16 to the list of mechanisms discussed so far. This variable can be interpreted in one of two ways. First, it might serve as a proxy for unobserved characteristics not included in the model that predict both smoking and education, such as better measures of future expectations or risk preferences or family or personal characteristics not measured directly. Alternatively, smoking and education might have a bi-directional relationship. Early school and family experiences may predict smoking status in mid adolescence, which in turn may predict smoking and educational status in adulthood. The results in columns 3–6 show that adding this variable to the model leaves nearly all of the other patterns unchanged—that is, this variable does not explain away the bulk of the theoretically-relevant mechanisms discussed above including those relating to future expectations. Net of these mechanisms, however, smoking by age 16 has a large association with both smoking and education status at age 26–29.

Those who smoked by age 16 have 5.8 times the odds of being in the "no college degree and smoking" group versus the "no college degree and non-smoking" group relative to those who did not smoke by age 16. The results in column 4 also show a large, robust association of smoking regularly in adolescence and later college entry. Compared to those who did

[8] As a robustness check, I also controlled for more detailed measures of socioeconomic status in adolescence such as family income, public assistance receipt, living with a parent who worked fulltime, and living in a neighborhood with no problem with trash or drugs. Only one of these measures is significant in the regressions described in Table 3. Living in a neighborhood with no problem at all with drugs predicts higher odds odd of being in the "college degree and non-smoking" group and in the "no college degree and non-smoking group" versus the "college degree and smoking" group. Including this variable, however, does not change the substantive results reported in Table 3 and requires dropping another 13% of the sample. None of these variables are significant if included in the regressions described in Table 2, and adding these variables does not change the substantive results reported.

not smoke by age 16, respondents who smoked by age 16 have nearly 50% lower odds of being in the "college degree and non-smoking" group versus the "no college degree and non-smoking" group. Because this contrast compares two groups that are both non-smoking in adulthood, this suggests that even when early smokers quit, they are more likely to end up in a lower educational category compared to those who are not early smokers. Finally, those who smoked regularly by age 16 have more than twice the odds of being in the "college degree and smoking" group versus the "no college degree and non-smoking" group. Smoking status at age 16 is correlated both with adult smoking status, net of a detailed set of covariates from the early teenage years, as well as completed education, when comparing adults with the same smoking status.

How should we interpret these results? Smoking regularly by age 16 might proxy for unobserved risk preferences, other family or personal characteristics, or childhood educational experiences not included in the model, which jointly determine education and smoking in adulthood. Alternatively, it might suggest that early smoking experience has an effect on later educational attainment, meaning that the relationship between education and smoking may be, in part, bi-directional. The analyses above cannot adjudicate between these two potential explanations. These results suggest that we need to look even earlier in the life course than ages 13–15 to understand the relationship between smoking and education in adulthood.

One of the interesting features of the results shown in Table 3 is that measures of cognitive and analytical skills (PVT scores and math or science courses) are not significant in the contrasts that have the same education but different smoking statuses. These results do not support the hypothesis that those with more analytical or cognitive skills are less likely to smoke (comparing across groups with the same education level). This is true both when comparing the lower education groups across smoking status and when comparing the college degree groups across smoking status (results for this latter contrast not shown in Table 3). Regardless of whether we interpret these measures as proxies for unmeasured cognitive and non-cognitive skills or as evidence for a causal effect of analytical skills on smoking, the results suggest that these characteristics are predictive of completed education but not smoking.

The results of the joint model of smoking and education also reveal a substantively important finding about the relationship between adolescents' expectations for the future and smoking and educational status in adulthood. Future expectations measured in the early teenage years can be distinguished between ones that are health-related and ones that are education-related. The health-related ones predict smoking in adulthood but not education, while educational aspirations predict college completion but not adult smoking (the results in Table 2 support this as well). This suggests that theories about the relationship between future expectations and the joint determination of education and smoking status need refinement. Health and education-related expectations operate in distinct ways. Although there may exist better measures of future expectations that tap more intrinsic measures of time horizons, the measures of future expectations in Add Health operate in distinct domains and do not predict outcomes outside that domain. This provides evidence against a one-dimensional conceptualization of future expectations as the "hidden third variable" explanation for the observed correlation between education and smoking in adulthood.

6. Discussion and conclusion

Age patterns of starting to smoke regularly show a distinct gradient by completed education from ages 12 to 18, long before that education is acquired. The mechanisms that produce the robust correlation between education and smoking in adulthood are rooted early in the life course. Although our existing theories for the mechanisms linking education and health are conceptualized as operating in adulthood, in case of smoking in adulthood, this is not the case. The causal mechanisms must be operating in childhood and adolescence. The analyses reported above show that a detailed view of early life experiences is a promising way of thinking about the links between education and smoking in adulthood. Although the set of potential mechanisms is inevitably incomplete, it offers a starting point for examining the links between education and smoking in a way that is consistent with the life course ties between these statuses from adolescence to adulthood.

The results show the following. First, it is possible to measure the mechanisms theorized to run from education to health, such as social networks, future expectations, information, and analytical skills, in adolescence, at the correct point in the life course to predict the initiation of smoking regularly. Table 2 shows that many of these characteristics from adolescence are significant predictors of smoking in adulthood. The results, however, argue against future expectations, at least as usually conceptualized, as being the characteristic that explains the correlation between education and smoking in adulthood. Similarly, cognitive or analytical skills are also not significant predictors of adult smoking, when comparing adults with the same education. Second, although many of the proposed theoretical mechanisms measured in adolescence predict smoking in adulthood, none predict *both* education and smoking status in adulthood. Only two variables considered above—smoking status at age 16 and having a parent who did not complete high school—predict both having more education and smoking in adulthood.

Taken together, these results suggest that the links between education and smoking in adulthood are better understood as a bundling of advantageous statuses that develops in childhood, rather than the effect of education producing better health. Indeed, education and smoking seem intertwined from such an early point in the life course that it is difficult to conceptualize or study the causal pathways in a simple way. Any approach that addresses the joint determination of these statuses would have to focus very early in life, and address the likely bi-directional relationship between cognitive and non-cognitive skills and school experiences. Moreover, even adolescence appears to be too late in the life course to identify the mechanisms

linking education and smoking in adulthood. Instead, we need to learn more precisely which characteristics before age 12 predict that a child will both not take up smoking in the teenage age years and enter and complete college later in life.

This reaches back to a point in the life course when the characteristics of individuals and those of their families of origin are extremely difficult to disentangle. This supports an important theoretical point developed in the current study. In understanding the links between education and smoking, we have to consider the relevant mechanisms as they relate not only to individuals but also to their families of origin. Educational attainment and good health not only represent statuses obtained by individuals, but also the family contexts that produce higher levels of the resources needed for obtaining these statuses later in life.

Families of origin and non-cognitive skills may matter far more than we have realized in explaining the correlation of education and smoking in adulthood. The childhood years are a time where school policies could actually make a difference, since nearly all children are in school in the primary grades. If, for example, the root cause(s) of the links between smoking and education in adulthood are characteristics nurtured by the family—be these optimism, self-esteem, self-control, or how to make good choices— schools could try to teach these skills as a way to offset inequalities produced at home. That is one way in which schooling could have a causal effect on smoking status in adulthood.

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