



National Center for
Education Statistics

U.S. Department of Education
Institute of Education Sciences
NCES 2005-333



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STATISTICS IN BRIEF

June 2005

Adolescent Cigarette Smoking: A Longitudinal Analysis Through Young Adulthood

Highlights

It is estimated that smoking results in more deaths each year in the United States than alcohol, cocaine, heroin, AIDS, suicide, homicide, motor vehicle accidents, and fires combined (U.S. Department of Health and Human Services 2000). With about 8 out of 10 adult smokers in the United States having tried their first cigarette before age 18 (U.S. Department of Health and Human Services 1994), it is not surprising that there has been considerable concern about adolescent smoking.

This analysis uses data from the National Education Longitudinal Study of 1988 (NELS:88), where the smoking behavior of a nationally representative cohort of 1988 eighth-graders was assessed at various time points over a 12-year period (i.e., from about age 14 to age 26). Data on smoking behavior were collected in 1988, when all study participants were in 8th grade; in 1990, when most were in 10th grade; in 1992, when most were in 12th grade; and in 2000, when most were 8 years removed from high school graduation. Participants in NELS:88 were not asked about their smoking behavior at the third follow-up in 1994. This took place 2 years after high school graduation for most individuals and when many were participating in postsecondary education.

In this report, the incidence of daily smoking at the various time points is shown. In addition, using the information obtained about individuals' smoking behavior over the time period, several specific developmental patterns are identified.

- *Nondaily smokers* included those who reported usually smoking not at all or less than one cigarette per day at each of the applicable survey waves (1988, 1990, 1992, and 2000).
- *Teen smokers* included those who reported usually smoking one or more cigarettes per day at either of the first three survey waves (1988, 1990, or 1992), but not at the last survey wave in 2000. Thus, individuals in this group either quit smoking or reduced their amount of smoking to less than one cigarette per day at the time of the young adult survey.
- *Teen/young adult smokers* included those who reported usually smoking one or more cigarettes per day at either of the first three survey waves (1988, 1990, or 1992) and at the last survey wave in 2000.

- *Late-onset smokers* included those who reported usually smoking one or more cigarettes per day at the last survey wave in 2000, but not at any of the prior survey waves (1988, 1990, and 1992). Thus, this group includes individuals who either began smoking as young adults, or who increased the frequency with which they smoked from less than daily during adolescence to one or more cigarettes each day at the time of the young adult survey.

Using this classification scheme, these developmental patterns were then examined in relation to various descriptive characteristics. The main findings from this analysis include the following:

- More individuals reported smoking at each subsequent survey follow-up (table 1). Six percent at 8th grade, 12 percent at 10th grade, 17 percent at 12th grade, and one-quarter at the young adult years reported usually smoking one or more cigarettes a day.¹ At the 10th grade, there were more new daily smokers than repeat daily smokers; however, the opposite was true at the young adult years.
- Examining individuals' smoking behavior over the time period, about two-thirds were nondaily smokers (68 percent), followed by teen/young adult smokers (15 percent), and then teen smokers (9 percent) and late-onset smokers (8 percent) (table 2). Accordingly, of the 24 percent of individuals who reported smoking as teenagers (i.e., adding together the teen smokers and teen/young adult smokers), almost two-thirds of them (63 percent) also reported smoking as young adults.
- Examining the four developmental patterns with respect to various descriptive characteristics, most of the characteristics that were related to daily smoking in the set of bivariate analyses (table 2) were also significant in a multivariate analysis (table 3). For example, individuals were more likely to be teen/young adult smokers than nondaily smokers if they were older as eighth-graders (i.e., those about 15 to 16 years old), if they were from a family

with a lower socioeconomic status (SES), or if they were from a single-parent or one-parent/one other guardian family rather than a two-parent family. In regards to race/ethnicity, Whites and Native Americans were more likely than Asians, Blacks, and Hispanics to be teen/young adult smokers as opposed to nondaily smokers. With respect to school type, students from public schools and Catholic schools were more likely than those from non-Catholic private schools to be teen/young adult smokers as opposed to nondaily smokers. Consistent with prior research, smoking was also associated with lower academic achievement. Daily teenage smoking (including both groups—teen smokers and teen/young adult smokers) was generally more prevalent among students with lower achievement scores, lower grades, and among those not participating in an academic program in high school.

Introduction

Cigarette smoking is the leading cause of preventable disease and death in the United States, where it is estimated that there are more deaths each year resulting from smoking than from alcohol, cocaine, heroin, AIDS, suicide, homicide, motor vehicle accidents, and fires combined (U.S. Department of Health and Human Services 2000). There are an estimated 440,000 tobacco-related deaths nationwide each year and approximately \$157 billion in annual health-related economic losses due to smoking (Centers for Disease Control and Prevention 2002a). With about 8 out of 10 adult smokers in the United States having tried their first cigarette before age 18 (U.S. Department of Health and Human Services 1994), it is not surprising that there has been considerable concern about adolescent smoking.

This analysis uses data from the National Education Longitudinal Study of 1988 (NELS:88), where the smoking behavior of a nationally representative cohort of 1988 eighth-graders was assessed at various time points over a 12-year period (i.e., from about age 14 to age 26). In this report, the incidence of daily smoking at the various time points is shown. In addition, using the information obtained about individuals' smoking behavior over the time period, several specific developmental patterns are identified and then examined in relation to various descriptive characteristics.

Comparisons made in the text of this report have been tested for statistical significance at the .05 level. Most

¹As previously noted, not all of the 1988 8th-graders were in 10th grade at the first follow-up in 1990 and not all of them were in 12th grade at the second follow-up in 1992 (e.g., some were held back a grade). But for ease of reporting, the 1990 survey wave will be referred to throughout this report as the "10th grade" and the 1992 survey wave will be referred to as the "12th grade." In addition, respondents at the 2000 survey wave will often be referenced as "young adults."

comparisons are tested with two-tailed *t* tests, although a multivariate analysis was performed to examine the independent association of several characteristics with smoking. Full details of statistical tests used can be found in the technical appendix. Statistical testing was done in an effort to ensure that the differences are larger than those that might be expected due to sampling variation, although for any given comparison there is a 5 percent chance that an observed significant difference may be due to chance.² Not all significant differences, however, are cited in the report. For example, in order to highlight those findings of substantive significance, only group differences of at least 5 percentage points are cited in the text.³ Because comparisons made in the report are delimited and focused through their reliance on findings from prior research, and because a criterion of substantive significance has been imposed, the *t* tests carried out in this analysis have not been adjusted for multiple comparisons.

What Is Known About Adolescent Smoking?

Since 1991, two national studies, Monitoring the Future (MTF) (Johnston et al. 2004a) and the Youth Risk Behavior Survey (YRBS) (Centers for Disease Control and Prevention 2002b), have tracked the prevalence of cigarette smoking nationally among adolescents at various grade levels.⁴ These trend results show that cigarette smoking among 8th- through 12th-graders increased during much of the 1990s, but has since declined from the peak levels reached around 1996–97. According to recent 2003 data from MTF, 5 percent of 8th-graders, 9 percent of 10th-graders, and 16 percent of 12th-graders were daily smokers (i.e., they reported smoking cigarettes daily during the 30 days preceding the survey). These findings are generally consistent with the 2001 YRBS. Using a slightly different measure, it was found that 14 percent of high school students were current frequent smokers—defined as smoking cigarettes on 20 or more of the 30 days preceding the survey.

²Some differences shown throughout the tables of this report may appear large but not be statistically significant. This is due in part to the relatively large standard errors surrounding some of the estimates (because of a relatively small sample size). For further information, see the section entitled *Statistical Tests* in the technical appendix.

³The selection of 5 percentage points as the criterion for a substantive difference when reporting comparisons of proportions is based on similar analyses in other NCES reports (e.g., NCES 2004–078 and NCES 2005–338), though it should be noted that the magnitude of effect that would be regarded as being of substantive or practical significance may vary depending on the types and contexts of the relationships and outcomes being measured.

⁴MTF began in 1975, but at first was limited to 12th-graders. In 1991, the study was expanded to include 8th- and 10th-graders.

A more limited number of longitudinal studies have tracked the frequency of smoking over time. These studies have shown that smoking is typically initiated during the adolescent years, and this behavior often persists or increases during this time (Chassin et al. 1990; Chen and Kandel 1995; Schulenberg et al. 1994). Whereas the use of other drugs such as alcohol and marijuana have been found to decline during the young adult years, smoking has been found to remain fairly persistent during this time (Bachman et al. 1997; Chassin et al. 1996; Chen and Kandel 1995).

More recently, some longitudinal research has gone beyond simply identifying general trends in smoking behavior. That is, a few studies have identified multiple developmental patterns in adolescent smoking. For example, studies have distinguished those adolescents who smoke at consistently high levels over time, those who increase their level of smoking or quit, those who initiate smoking only later on in adolescence, etc. (Chassin et al. 1991, 2000; Colder et al. 2001; Orlando et al. 2004; White, Pandina, and Chen 2002). Identifying distinct patterns of smoking and understanding factors related to these patterns has implications for research and intervention, including efforts aimed at smoking prevention.

Studies that have specifically looked at adolescent smoking in relation to various individual or family characteristics have found that Whites are more likely to smoke compared to other racial/ethnic groups (Centers for Disease Control and Prevention 1998, 2002b, 2003; Orlando et al. 2004; Wills and Cleary 1997). In addition, nonsmokers are more likely than consistent smokers to come from intact nuclear families or from families with more highly educated parents (Orlando et al. 2004).

Other research has shown that adolescents who smoke also tend to have weaker ties to parents and school, more school behavior problems, and lower levels of self-esteem, academic achievement, and educational attainment (Bryant et al. 2000; Centers for Disease Control and Prevention 1998; Conrad, Flay, and Hill 1992; Schulenberg et al. 1994; U.S. Department of Health and Human Services 1994; White, Pandina, and Chen 2002). Adolescent smokers are also more likely to drop out of high school (Ellickson et al. 1998; Mensch and Kandel 1988) and more likely to use alcohol and other drugs (Substance Abuse and Mental Health Services Administration 2001; White, Pandina, and Chen 2002). These correlational findings do not imply causal connections between smoking and other family and individual characteristics. However, they do indicate that adolescent smoking is associated with other adolescent behaviors and characteristics that may

reflect lower levels of engagement in learning and more alienation from parents and school.

There are, however, various limitations in past studies on adolescent smoking. For example, many studies are cross-sectional and utilize grade-specific samples (e.g., Centers for Disease Control and Prevention 2002b, 2003; Johnston et al. 2004a). Thus, changes in individuals over time cannot be measured, and high school dropouts are excluded. Many longitudinal studies also may exclude high school dropouts (e.g., Chassin et al. 1990, 1996, and 2000; Colder et al. 2001). Furthermore, some longitudinal studies are limited in their timeframe, thus not incorporating both the adolescent and young adult years (e.g., Bachman et al. 1997; Colder et al. 2001), whereas others rely on retrospective data (e.g., Chen and Kandel 1995). In addition, some studies have a relatively small sample size (e.g., White, Pandina, and Chen 2002) or have limited racial/ethnic, socioeconomic, and geographic diversity (e.g., Chassin et al. 1990, 1996, and 2000). Also, although a number of studies consider smoking in relation to various individual or family characteristics, these characteristics are often limited in scope due to limitations in the survey methodology (e.g., student self-report, mail-in surveys), and as previously noted, only a limited number of such studies identify multiple developmental patterns of smoking (i.e., Chassin et al. 1991, 2000; Orlando et al. 2004; White, Pandina, and Chen 2002).

Research Objectives

To address prior limitations and expand the existing body of research on adolescent smoking, the present analysis uses data from the National Education Longitudinal Study of 1988 (NELS:88), which provides longitudinal data about the critical transitions experienced by members of the eighth-grade class of 1988 in the United States (i.e., those attending traditional public and private schools) as they developed, attended school, embarked on careers, and formed families. There were 10,827 individuals who participated in the base-year survey (1988) and the four subsequent follow-ups—in 1990, 1992, 1994, and, most recently, in 2000.

Major strengths of the present study include its longitudinal design that spans from early adolescence well into young adulthood, and a methodology that can identify distinct developmental patterns of smoking across this time period. These developmental patterns are further examined in relation to individual demographic characteristics, family demographic characteristics, and various education-related characteristics. Another major strength of the

present study is that it includes measures that do not rely on student self-report (e.g., family socioeconomic status and student achievement scores) as well as some additional measures that have not been looked at in previous studies on adolescent smoking (e.g., high school program participation). Furthermore, the study utilizes a large, nationally representative sample. Whereas much of the data on adolescent smoking come from grade-based samples that exclude high school dropouts, NELS:88 included in its follow-ups those who had fallen out of grade sequence (such as through having repeated a grade) and those who had dropped out of high school. This has implications with respect to the generalizability of findings. For example, research has found that the incidence of dropping out varies along such characteristics as socioeconomic status and race/ethnicity (Kaufman, Alt, and Chapman 2001). Thus, the exclusion of high school dropouts can lead to biases in the data by disproportionately eliminating certain population subgroups.

In sum, the three primary aims of this report are to

- identify the incidence of daily smoking at several time points during the adolescent and young adult years, including the prevalence of new daily smokers relative to repeat daily smokers;
- identify several specific developmental patterns of smoking from the information obtained about individuals' smoking behavior over the time period; and
- examine the specific developmental patterns of smoking in relation to various descriptive characteristics.

Smoking as Assessed in NELS:88

In NELS:88, the prevalence of cigarette smoking was assessed at four survey waves—1988, 1990, 1992, and 2000. All respondents were in 8th-grade at the initial 1988 survey, and most were in 10th grade as of the 1990 survey, in 12th grade as of the 1992 survey, and about 26 years old as of the 2000 survey—conducted 8 years after most respondents had graduated from high school.⁵ At each of these survey waves, respondents were asked how many cigarettes they usually smoked in a day. For this analysis, those who indicated smoking one or more

⁵As noted, not all individuals in 1990 were in 10th grade and not all in 1992 were in 12th grade (e.g., some were held back a grade). But for ease of reporting, the 1990 survey wave will be referred to throughout this report as the “10th grade” and the 1992 survey wave will be referred to as the “12th grade.” In addition, respondents at the 2000 survey wave will often be referenced as “young adults.”

cigarettes a day were classified as daily smokers. Nondaily smokers included those who reported that they did not smoke or who reported smoking less than one cigarette a day.⁶ Note that participants in NELS:88 were not asked about their smoking behavior at the third follow-up in 1994. This took place 2 years after high school graduation for most individuals and when many were attending postsecondary education.

This *Statistics in Brief* uses a relatively simplified approach of classifying individuals either as daily smokers or nondaily smokers at the various survey waves rather than, for example, differentiating nonsmokers, occasional smokers, and heavy smokers at each of the four survey waves. While a number of factors went into the decision to use the current approach, there were two main factors. First, distinguishing daily smokers from nondaily smokers is consistent with what has been done in a number of other recent studies on adolescent smoking (e.g., Adalbjarnardottir and Rafnsson 2001; Burt et al. 2000; Johnson, McCaul, and Klein 2002; Windle and Windle 2001; Willoughby, Chalmers, and Busseri 2004). Second, smoking daily is related to a number of unfavorable developmental outcomes, and as such, is characterized as a particularly risky and problematic behavior (Johnson, McCaul, and Klein 2002; U.S. Department of Health and Human Services 1994; Willoughby, Chalmers, and Busseri 2004). Adolescents who, on average, smoke daily or almost daily for several years are at particular risk for health problems and have generally been found to have lower levels of educational attainment, greater use of other drugs, and more psychosocial adjustment problems compared to those who abstain from smoking or who smoke infrequently or quit (Chassin et al. 2000; Orlando et al. 2004).

Prevalence of Daily Smoking at Various Time Points During Adolescence and Young Adulthood

More individuals reported daily smoking at each subsequent survey follow-up (table 1). Six percent at 8th grade, 12 percent at 10th grade, 17 percent at 12th grade, and one-quarter at the young adult years reported usually smoking one or more cigarettes a day. At each wave of data collection, it was considered whether an individual who reported smoking was a new daily smoker (i.e., did not report daily smoking at a previous survey wave) or a repeat daily smoker (i.e., reported daily smoking at a previous survey wave). Results show that at the 10th grade there were more new daily smokers than repeat daily

smokers; however, the opposite was true at the young adult years (the average age being 26). That is, at the 10th grade there were about three times as many new daily smokers as repeat daily smokers (9 vs. 3 percent). However, among the young adults there were about twice as many repeat daily smokers as new daily smokers (13 vs. 7 percent).

Developmental Patterns of Daily Smoking and Nondaily Smoking: A Descriptive Profile

The prior analysis was meant to provide a snapshot of the prevalence of daily smoking at various time points during the adolescent and young adult years. A second set of analyses was then carried out in which multiple developmental patterns of smoking were identified, which is similar to what has been done in prior studies (Chassin et al. 1991, 2000; Orlando et al. 2004; White, Pandina, and Chen 2002). In this analysis, several distinct developmental patterns were derived from the information obtained about the NELS:88 8th-grade cohort's smoking behavior over the time period.

- *Nondaily smokers* included those who reported usually smoking not at all or less than one cigarette per day at each of the applicable survey waves (1988, 1990, 1992, and 2000).
- *Teen smokers* included those who reported usually smoking one or more cigarettes per day at either of the first three survey waves (1988, 1990, or 1992), but not at the last survey wave in 2000. Thus, individuals in this group either quit smoking or reduced their amount of smoking to less than one cigarette per day at the time of the young adult survey.
- *Teen/young adult smokers* included those who reported usually smoking one or more cigarettes per day at either of the first three survey waves (1988, 1990, or 1992) and at the last survey wave in 2000.
- *Late-onset smokers* included those who reported usually smoking one or more cigarettes per day at the last survey wave in 2000, but not at any of the prior survey waves (1988, 1990, and 1992). Thus, this group includes individuals who either began smoking as young adults, or who increased the frequency with which they smoked from less than daily during adolescence to one or more cigarettes each day at the time of the young adult survey.

⁶The response option of "less than one cigarette a day," however, was not offered at the initial 1988 survey wave.

Table 1. Percentage distribution of 1988 eighth-graders' cigarette smoking trends, by survey wave: Various years, 1988 to 2000

Survey wave	Nondaily smokers	Daily smokers			
		Total	Repeat ¹	New ²	Other ³
1988 (all in eighth grade)	93.7 (0.45)	6.3 (0.45)	—	—	—
1990 (most in 10th grade)	88.0 (0.53)	12.0 (0.53)	3.1 (0.30)	8.8 (0.44)	0.2 (0.05)
1992 (most in 12th grade) ⁴	83.5 (0.69)	16.5 (0.69)	8.5 (0.50)	6.9 (0.31)	1.1 (0.44)
2000 (most at age 25 or 26)	74.7 (0.76)	25.3 (0.76)	13.1 (0.65)	7.0 (0.30)	5.2 (0.49)

— Not available.

¹Include those daily smokers who also reported daily smoking at a previous survey wave.

²Include those daily smokers who did not report daily smoking at any previous survey wave.

³Include those daily smokers who had missing data at a previous survey wave(s) that precluded them from being classified as "repeat daily smokers" or "new daily smokers."

⁴Item response rate is below 85 percent (i.e., 82 percent), and missing data have not been explicitly accounted for in the data. See the technical appendix under *Variables Used in Analysis—Smoking and nonsmoking* for a bias analysis of nonrespondents.

NOTE: Nondaily smokers include those who reported usually smoking not at all or less than one cigarette per day; daily smokers include those who reported usually smoking one or more cigarettes per day. Detail may not sum to totals because of rounding. Standard errors appear in parentheses.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year, Student Survey, 1988;" "First Follow-up, Student Survey, 1990;" "Second Follow-up, Student Survey, 1992;" "Fourth Follow-up, Student Survey, 2000."

It is important to bear in mind that reports of daily smoking (or nondaily smoking) at two consecutive time points does not mean that there was continuous daily smoking (or nondaily smoking) over that time period. For example, an individual who reported smoking in 1990 and 2000 would be classified as a teen/young adult smoker; however, this does not mean that the person smoked continuously throughout the 10-year period.

Overall Patterns of Smoking

Using the information obtained about individuals' smoking behavior over time, 85 percent were classified into one of the four developmental patterns.⁷ Of these, about two-thirds were nondaily smokers (68 percent), followed by teen/young adult smokers (15 percent), and then teen smokers (9 percent) and late-onset smokers (8 percent) (table 2). Adding together the teen smokers and teen/young adult smokers indicates that about one-quarter of individuals (24 percent) reported that they usually smoked cigarettes daily at some point during their teenage years. Of these, almost two-thirds of them (63 percent) also reported smoking daily as young adults (i.e., the 15 percent who are teen/young adult smokers).

In the sections that follow, the patterns of smoking are shown by various descriptive characteristics. Readers should consult the technical appendix in the section entitled *Variables Used in Analysis* for additional information about the variables used for these characteristics.

⁷The other 15 percent reported daily smoking or nondaily smoking at one or more survey waves, but had missing data at various survey waves that precluded their classification into one of the four categories. Thus, these cases were not included in the main analyses of this report and the results shown in tables 2 and 3. However, a bias analysis of these excluded cases can be found in the technical appendix under *Variables Used in Analysis—Smoking and nonsmoking*.

Patterns of Smoking by Individual Demographic Characteristics

Three individual demographic characteristics were considered in relation to the patterns of smoking: sex, race/ethnicity, and age.

Sex. There were more females who were nondaily smokers compared to males (70 vs. 65 percent). However, no difference was detected in the prevalence of males and females who were teenage smokers overall (i.e., adding together the teen smokers and teen/young adult smokers). This is consistent with other studies over the past decade that have generally not detected sex differences in current smoking among middle school and high school students (Byrnes, Miller, and Schafer 1999; Centers for Disease Control and Prevention 2002b, 2003).

Race/ethnicity. More Asians, Blacks, and Hispanics were nondaily smokers than Whites (79, 85, and 74 percent, respectively, compared to 64 percent). Likewise, fewer Asians, Blacks, and Hispanics were teen/young adult smokers than Whites (6, 5, and 8 percent, respectively, compared to 18 percent). Furthermore, more Blacks were nondaily smokers than Hispanics and Native Americans (71 percent), and fewer Blacks were teen smokers than Hispanics and Whites (3 percent compared to 12 and 10 percent, respectively). About one in five (19 percent) Native Americans was a teen/young adult smoker, a rate higher than that of Asians, Blacks, and Hispanics. A similar overall pattern of racial/ethnic differences in adolescent smoking has been found in other studies over the past decade (Centers for Disease Control and Prevention 1998, 2002b, 2003; Orlando et al. 2004; Wills and Cleary 1997), although some recent studies suggest very little in the way of racial/ethnic differences at the middle-

Table 2. Percentage distribution of 1988 eighth-graders' cigarette smoking patterns, by selected characteristics: Various years, 1988 to 2000

Characteristic	Nondaily smokers ¹	Teen smokers ²	Teen/young adult smokers ³	Late-onset smokers ⁴
Total	67.6 (0.82)	9.0 (0.45)	15.2 (0.74)	8.2 (0.34)
Sex				
Male	65.0 (1.24)	8.7 (0.64)	16.3 (1.14)	10.0 (0.58)
Female	70.2 (1.02)	9.2 (0.57)	14.1 (0.79)	6.5 (0.41)
Race/ethnicity				
Asian/Pacific Islander	78.8 (2.39)	7.2 (1.79)	5.7 (1.09)	8.3 (1.64)
Black, non-Hispanic	85.1 (2.73)	2.5 (0.84)	5.1 (2.47)	7.3 (1.22)
Hispanic	74.2 (2.06)	11.5 (1.56)	8.2 (1.24)	6.1 (0.96)
Native American/Alaska Native	71.3 (6.00)	4.2 (2.10)	19.3 (4.40)	5.1 (2.54)
White, non-Hispanic	63.8 (0.90)	9.7 (0.51)	17.8 (0.87)	8.7 (0.40)
Age in eighth grade				
13–14 years old (born 1974 or 1975)	71.4 (0.82)	8.2 (0.49)	12.2 (0.55)	8.2 (0.40)
15–16 years old (born 1972 or 1973)	60.2 (1.74)	10.1 (0.85)	21.5 (1.80)	8.3 (0.71)
Socioeconomic status (eighth grade, parent report)				
Low (lowest quartile)	62.2 (2.20)	8.9 (0.90)	22.4 (2.32)	6.5 (0.65)
Middle (middle two quartiles)	65.8 (1.00)	10.2 (0.67)	15.4 (0.82)	8.7 (0.47)
High (highest quartile)	74.3 (1.28)	7.0 (0.69)	10.1 (1.09)	8.5 (0.70)
Family composition (eighth grade, student report)				
Two parents	71.1 (0.80)	8.2 (0.45)	12.4 (0.58)	8.2 (0.41)
One parent and other guardian	56.9 (2.91)	13.5 (1.81)	20.7 (3.19)	8.9 (1.14)
Single parent	64.9 (1.96)	7.3 (0.83)	20.1 (1.76)	7.7 (0.94)
Other ⁵	51.0 (8.20)	11.0 (3.78)	29.0 (8.75)	9.0 (2.81)
Achievement scores, reading and mathematics (eighth grade)				
Low (lowest quartile)	60.3 (2.12)	11.4 (1.28)	21.7 (1.72)	6.5 (0.77)
Middle (middle two quartiles)	64.6 (1.18)	9.8 (0.65)	17.1 (1.13)	8.5 (0.50)
High (highest quartile)	77.1 (0.99)	6.2 (0.56)	7.5 (0.60)	9.2 (0.66)
Student-reported grades (grade 6 until grade 8 current)				
Low (lowest quartile)	48.4 (2.30)	14.1 (1.27)	30.0 (2.45)	7.4 (0.67)
Middle (middle two quartiles)	66.6 (1.05)	9.3 (0.64)	14.8 (0.86)	9.4 (0.57)
High (highest quartile)	81.5 (0.89)	5.3 (0.48)	5.9 (0.59)	7.2 (0.56)
Type of school attended in eighth grade				
Public	66.9 (0.88)	8.9 (0.47)	16.0 (0.82)	8.1 (0.37)
Catholic	70.2 (2.19)	9.0 (1.32)	11.1 (1.26)	9.8 (1.17)
Other private	75.5 (3.57)	10.6 (3.00)	6.2 (1.61)	7.7 (1.82)
After eighth grade, high school program participation				
Academic	74.7 (0.78)	7.2 (0.43)	9.4 (0.60)	8.7 (0.40)
Vocational	49.8 (2.80)	11.9 (1.84)	28.3 (2.61)	10.0 (1.60)
Other	52.3 (2.01)	13.3 (1.23)	27.7 (2.08)	6.7 (0.72)

¹Include those who reported usually smoking not at all or less than one cigarette per day at each of the applicable survey waves (1988, 1990, 1992, and 2000).

²Include those who reported usually smoking one or more cigarettes per day at either of the first three survey waves (1988, 1990, or 1992) but not at the last survey wave in 2000. Some may have smoked cigarettes even daily beyond the teenage years and into their early twenties. But for the purpose of this analysis, they are referred to as "teen smokers" for ease of reference and to distinguish them from the "teen/young adult smokers." Unlike the teen/young adult smokers, the teen smokers did not report daily smoking when in their mid-twenties.

³Include those who reported usually smoking one or more cigarettes per day at either of the first three survey waves (1988, 1990, or 1992) and at the last survey wave in 2000.

⁴Include those who reported usually smoking one or more cigarettes per day at the last survey wave in 2000 but not at any of the prior survey waves (1988, 1990, and 1992). Some may have been smoking daily as early as the late teenage years (e.g., sometime after the 12th grade). But for the purpose of this analysis, they are referred to as "late-onset smokers" for ease of reference and to distinguish them from the "teen smokers" and "teen/young adult smokers."

⁵Includes those who reported living with an other relative besides a parent or living with a nonrelative.

NOTE: All respondents were in eighth grade in the 1988 base-year survey wave (modal age of 14). Most respondents were in 10th grade as of the 1990 survey wave, 12th grade as of the 1992 survey wave, and 8 years after regular high school graduation as of the 2000 survey wave (modal ages of 16, 18, and 26, respectively). Percentage distribution shown is for the 85 percent of individuals who were classified into one of the four developmental patterns. The other 15 percent reported daily smoking or nondaily smoking at one or more survey waves but had missing data at various survey waves that precluded their classification into one of the four patterns. See the technical appendix under *Variables Used in Analysis—Smoking and nonsmoking* for a discussion about data imputations for some of the patterns and for a bias analysis of excluded cases. Detail may not sum to totals because of rounding. Standard errors appear in parentheses.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year, Student Survey, 1988;" "Base Year, Parent Survey, 1988;" "Base Year, School Survey, 1988;" "First Follow-up, Student Survey, 1990;" "Second Follow-up, Student Survey, 1992;" "Second Follow-up, Transcript Survey, 1992;" "Third Follow-up, Student Survey, 1994;" "Fourth Follow-up, Student Survey, 2000."

school level (Centers for Disease Control and Prevention 2000, 2003). Trend data from Monitoring the Future (MTF) show that racial/ethnic differences among eighth-graders have narrowed over the past several years—largely the result of a decline in smoking among Whites. For example, the rate of daily smoking among White eighth-graders declined from 12 percent in 1995–96 to 5 percent in 2002–03 (Johnston et al. 2004b). Among Hispanic eighth-graders, the rate of daily smoking went from 8 percent to 4 percent during this same time period, and for Black eighth-graders the rate was between 3 and 4 percent throughout this time period.

Age. There were more nondaily smokers among individuals who were younger as eighth-graders (i.e., those about 13 to 14 years old) than among their older peers (i.e., those about 15 to 16 years old in eighth grade) (71 vs. 60 percent). Likewise, fewer of the younger individuals were teen/young adult smokers compared to the older individuals (12 vs. 21 percent). No differences by age were detected for the teen smokers and late-onset smokers.

Patterns of Smoking by Family Demographic Characteristics

In an effort to shed light on the context that smoking occurs in, it is useful to explore family characteristics in relation to these developmental patterns. Two family characteristics assessed in the eighth grade were considered in this analysis: family socioeconomic status and family composition.

Family socioeconomic status (SES). SES was derived from parent-questionnaire data obtained when students were in the eighth grade. Each individual received a composite scale score based on father's education level, mother's education level, father's occupation, mother's occupation, and family income. For this analysis, scores were divided into three levels: low (lowest quartile), middle (middle two quartiles), and high (highest quartile). Results show that there were more nondaily smokers among those at the high SES level than among their peers at the low and middle SES levels (74 percent compared to 62 and 66 percent, respectively). Similarly, there were fewer teen/young adult smokers at each higher SES level (22, 15, and 10 percent for the low-, middle-, and high-SES groups, respectively).

Family composition. More individuals from two-parent families were nondaily smokers than those from the other family compositions shown (71 percent compared to a range from 51 to 65 percent). Similarly, fewer individuals from two-parent families were teen smokers than those

from families with one parent and one other guardian (8 vs. 14 percent), and fewer individuals from two-parent families were teen/young adult smokers than those from single-parent families and those from families with one parent and one other guardian (12 percent compared to 20 and 21 percent, respectively). More individuals from single-parent families were nondaily smokers than those from families with one parent and one other guardian (65 vs. 57 percent). Likewise, fewer individuals from single-parent families were teen smokers compared to those from one-parent/one other guardian families (7 vs. 14 percent).

Patterns of Smoking by Education-Related Characteristics

As previously noted, prior research has found that lower academic achievement among adolescents is associated with smoking (Bryant et al. 2000; Ellickson et al. 1998; Mensch and Kandel 1988; Schulenberg et al. 1994; White, Pandina, and Chen 2002). This relationship was generally explored in the present analysis by examining two specific achievement characteristics from the eighth grade: achievement scores and average grades.

Achievement scores. In addition to completing a student background questionnaire on their school and life experiences, eighth-graders were administered cognitive tests in reading comprehension, mathematics, science, and history/citizenship/geography. In this analysis, a combined score from the reading comprehension and mathematics tests was used, with the score broken down into three levels: low (lowest quartile), middle (middle two quartiles), and high (highest quartile). Results show that students who performed higher on the assessment were generally less likely to smoke. For example, more high-performing students were nondaily smokers than low- and middle-performing students (77 percent compared to 60 and 65 percent, respectively); likewise, fewer high-performing students were teen smokers compared to their low-performing peers (6 vs. 11 percent). Similarly, there were fewer teen/young adult smokers at each higher level of achievement (22, 17, and 8 percent, respectively, for the low, middle, and high achievement levels).

Average grades. Eighth-graders were asked to describe their school grades from grade 6 up until the time of data collection (i.e., spring of eighth grade) in four subject areas: English, mathematics, science, and social studies. The response categories in these subject areas were converted to a five-point scale (i.e., mostly As = 4.0, mostly Bs = 3.0, mostly Cs = 2.0, mostly Ds = 1.0, and mostly below D = 0.5), and a quartile distribution of the averaged

scores was created. For this analysis, students' grades were classified into three levels: low (lowest quartile), middle (middle two quartiles), and high (highest quartile). Results show that students who reported earning higher grades were generally less likely to smoke. For example, at each higher level of average grades, there were more nondaily smokers (48, 67, and 82 percent, respectively) and fewer teen/young adult smokers (30, 15, and 6 percent, respectively). In addition, fewer middle- and high-performing students were teen smokers than their low-performing peers (9 and 5 percent compared to 14 percent).

Lastly, school contextual factors were explored in relation to the patterns of smoking by considering the type of school attended in eighth grade (i.e., public, Catholic, and other private schools) and the type of program individuals participated in later in high school (i.e., academic, vocational, or other high school programs).

School type. More students from non-Catholic private schools were nondaily smokers compared to public school students (75 vs. 67 percent), and fewer students from non-Catholic private schools were teen/young adult smokers compared to public school students (6 vs. 16 percent). In addition, fewer Catholic school students were teen/young adult smokers (11 percent) compared to public school students, although this rate was higher than that of their counterparts at non-Catholic private schools.

Program type. In this analysis, program type refers to the most recent program that a student was involved in at his/her last high school. Results show that more individuals from academic high school programs were nondaily smokers than those from vocational or other high school programs (75 percent compared to 50 and 52 percent, respectively). Likewise, there were fewer individuals among those from academic high school programs than among those from vocational or other high school programs who were teen smokers (7 percent compared to 12 and 13 percent, respectively) and teen/young adult smokers (9 percent compared to 28 percent for both vocational and other high school programs).

Results from Multivariate Analysis

All of the characteristics examined in the series of bivariate analyses discussed above were related to smoking to some extent. However, some of these characteristics may be related to each other. In order, then, to examine the independent association of these characteristics with smoking, a multivariate analysis was conducted. Specifically, a

multinomial logistic regression analysis was performed to determine whether each of these characteristics is related to the smoking patterns when controlling for the other characteristics. (See the appendix section under *Statistical Tests—Multivariate analysis* for further discussion about this procedure.)

Results show that most of the characteristics that were related to the smoking patterns at the bivariate level were also significant at the multivariate level (table 3). In other words, many of these characteristics were independently associated with smoking when accounting for the other individual, family, and education-related characteristics. Across the three smoking patterns (i.e., teen smokers, teen/young adult smokers, and late-onset smokers), individuals were more likely to be daily smokers than nondaily smokers if they were White as opposed to Black, if they reported earning lower grades during the middle-school years, or if they participated in a vocational high school program as opposed to an academic high school program.

In addition, individuals were more likely to be teen smokers and teen/young adult smokers than nondaily smokers if they were Asian or Hispanic as opposed to Black, if they were older than their eighth-grade peers, if they were from a family with one parent and one other guardian rather than a two-parent family, or if they participated in other (nonvocational) high school programs as opposed to an academic high school program.

There were also several other characteristics that were related to smoking, but only for teen/young adult smoking. That is, individuals were more likely to be teen/young adult smokers than nondaily smokers if they were White or Native American as opposed to Asian, Black, or Hispanic; if they were from a family with a lower SES or from a single-parent family rather than a two-parent family; if they had lower standardized test scores as eighth-graders; or if they attended a public or Catholic school in eighth grade as opposed to a private non-Catholic school.

The only sex difference found in the smoking patterns was that males were more likely than females to be late-onset smokers as opposed to nondaily smokers.

Summary and Conclusion

In a longitudinal analysis that spanned three grade levels—grades 8, 10, and 12—and well into young adulthood, it was found that daily cigarette smoking increased at each subsequent time point. Six percent at 8th grade, 12 percent at 10th grade, 17 percent at 12th grade, and

Table 3. Results of multinomial logistic regression analysis for cigarette smoking patterns, by selected characteristics: Various years, 1988 to 2000

Smoking pattern and characteristic	Coefficient	Standard error	t-statistic	Odds ratio
Teen smokers¹				
Constant	-0.09	0.354	-0.25	†
Sex (reference category: male)				
Female	0.12	0.111	1.08	1.13
Race/ethnicity (reference category: White, non-Hispanic)				
Asian/Pacific Islander	-0.23	0.277	-0.85	0.79
Black, non-Hispanic	-1.91*	0.323	-5.91	0.15
Hispanic	-0.28	0.178	-1.58	0.75
Native American/Alaska Native	-1.02	0.540	-1.88	0.36
Age in eighth grade				
(reference category: younger—13 to 14 years old)				
Older (15 to 16 years old)	0.24*	0.120	1.99	1.27
Socioeconomic status (eighth grade, parent report)				
(reference category: two parents)				
One parent and other guardian	0.60*	0.167	3.60	1.82
Single parent	-0.05	0.144	-0.37	0.95
Other ²	0.65	0.412	1.57	1.91
Achievement scores, reading and mathematics (eighth grade)				
(reference category: grade 6 until grade 8 current)				
Student-reported grades (grade 6 until grade 8 current)	-0.59*	0.088	-6.76	0.55
Type of school attended in eighth grade				
(reference category: public)				
Catholic	0.20	0.188	1.05	1.22
Other private	0.17	0.328	0.52	1.18
After eighth grade, high school program participation				
(reference category: academic)				
Vocational	0.51*	0.186	2.77	1.67
Other	0.71*	0.138	5.11	2.03
Teen/young adult smokers³				
Constant	1.10*	0.328	3.35	†
Sex (reference category: male)				
Female	-0.06	0.097	-0.58	0.95
Race/ethnicity (reference category: White, non-Hispanic)				
Asian/Pacific Islander	-1.07*	0.228	-4.70	0.34
Black, non-Hispanic	-2.94*	0.293	-10.04	0.05
Hispanic	-1.43*	0.180	-7.92	0.24
Native American/Alaska Native	-0.29	0.323	-0.88	0.75
Age in eighth grade				
(reference category: younger—13 to 14 years old)				
Older (15 to 16 years old)	0.24*	0.111	2.21	1.28
Socioeconomic status (eighth grade, parent report)				
(reference category: two parents)				
One parent and other guardian	0.44*	0.148	2.96	1.55
Single parent	0.34*	0.129	2.62	1.40
Other ²	0.55	0.335	1.65	1.74

See notes at end of table.

Table 3. Results of multinomial logistic regression analysis for cigarette smoking patterns, by selected characteristics: Various years, 1988 to 2000—Continued

Smoking pattern and characteristic	Coefficient	Standard error	t-statistic	Odds ratio
Achievement scores, reading and mathematics (eighth grade)	-0.01*	0.007	-2.14	0.99
Student-reported grades (grade 6 until grade 8 current)	-0.76*	0.090	-8.49	0.47
Type of school attended in eighth grade (reference category: public)				
Catholic	0.11	0.149	0.75	1.12
Other private	-0.73*	0.317	-2.31	0.48
After eighth grade, high school program participation (reference category: academic)				
Vocational	0.85*	0.139	6.09	2.34
Other	1.11*	0.109	10.21	3.03
Late-onset smokers⁴				
Constant	-1.55*	0.331	-4.68	†
Sex (reference category: male)				
Female	-0.45*	0.102	-4.46	0.63
Race/ethnicity (reference category: White, non-Hispanic)				
Asian/Pacific Islander	-0.14	0.227	-0.59	0.87
Black, non-Hispanic	-0.51*	0.211	-2.41	0.60
Hispanic	-0.53*	0.190	-2.80	0.59
Native American/Alaska Native	-0.53	0.544	-0.98	0.59
Age in eighth grade (reference category: younger—13 to 14 years old)				
Older (15 to 16 years old)	0.14	0.114	1.25	1.15
Socioeconomic status (eighth grade, parent report)	-0.05	0.079	-0.67	0.95
Family composition (eighth grade, student report) (reference category: two parents)				
One parent and other guardian	0.29	0.157	1.87	1.34
Single parent	0.03	0.160	0.19	1.03
Other ²	0.56	0.392	1.44	1.76
Achievement scores, reading and mathematics (eighth grade)	0.01	0.006	1.76	1.01
Student-reported grades (grade 6 until grade 8 current)	-0.32*	0.082	-3.88	0.73
Type of school attended in eighth grade (reference category: public)				
Catholic	0.25	0.147	1.70	1.29
Other private	-0.13	0.254	-0.52	0.88
After eighth grade, high school program participation (reference category: academic)				
Vocational	0.45*	0.205	2.18	1.56
Other	0.08	0.135	0.60	1.08

† Not applicable.

* $p < .05$.

¹Include those who reported usually smoking one or more cigarettes per day at either of the first three survey waves (1988, 1990, or 1992) but not at the last survey wave in 2000. Some may have smoked cigarettes even daily beyond the teenage years and into their early 20's. But for the purpose of this analysis, they are referred to as "teen smokers" for ease of reference and to distinguish them from the "teen/young adult smokers." Unlike the teen/young adult smokers, the teen smokers did not report daily smoking when in their mid-twenties.

²Includes those who reported living with an other relative besides a parent or living with a nonrelative.

³Include those who reported usually smoking one or more cigarettes per day at either of the first three survey waves (1988, 1990, or 1992) and at the last survey wave in 2000.

⁴Include those who reported usually smoking one or more cigarettes per day at the last survey wave in 2000 but not at any of the prior survey waves (1988, 1990, and 1992). Some may have been smoking daily as early as the late teenage years (e.g., sometime after the 12th grade). But for the purpose of this analysis, they are referred to as "late-onset smokers" for ease of reference and to distinguish them from the "teen smokers" and "teen/young adult smokers."

NOTE: All respondents were in eighth grade in the 1988 base-year survey wave (modal age of 14). Most respondents were in 10th grade as of the 1990 survey wave, 12th grade as of the 1992 survey wave, and 8 years after regular high school graduation as of the 2000 survey wave (modal ages of 16, 18, and 26, respectively). Data shown are for the 85 percent of individuals who were classified into one of the four patterns of daily smoking and nondaily smoking. The other 15 percent reported daily smoking or nondaily smoking at one or more survey waves but had missing data at various survey waves that precluded their classification into one of the four patterns. See the technical appendix under *Variables Used in Analysis—Smoking and Nonsmoking* for a discussion about data imputations for some of the patterns and for a bias analysis of excluded cases. Sample size for regression analysis is 8,918.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year, Student Survey, 1988;" "Base Year, Parent Survey, 1988;" "Base Year, School Survey, 1988;" "First Follow-up, Student Survey, 1990;" "Second Follow-up, Student Survey, 1992;" "Second Follow-up, Transcript Survey, 1992;" "Third Follow-up, Student Survey, 1994;" "Fourth Follow-up, Student Survey, 2000."

one-quarter at the age of about 26 years reported usually smoking one or more cigarettes a day. These results are generally consistent with the findings from other studies. For example, just as this study found that in 1992 17 percent of individuals—most of whom were in 12th grade—were daily smokers, so too did the national Monitoring the Future (MTF) study find that in 1992 17 percent of 12th-graders were daily smokers (Johnston et al. 2004a).

Results also show that at the 10th grade there were more new daily smokers than repeat daily smokers; however, the opposite was true at the young adult years. That is, at the 10th grade there were about three times as many new daily smokers as repeat daily smokers (9 vs. 3 percent). However, among the young adults there were about twice as many repeat daily smokers as new daily smokers (13 vs. 7 percent).

In a separate analysis that uses the information obtained about individuals' smoking behavior over the time period, several specific developmental patterns were derived. About two-thirds (68 percent) were nondaily smokers, followed by teen/young adult smokers (15 percent), and then teen smokers (9 percent) and late-onset smokers (8 percent). Accordingly, of the 24 percent of individuals who reported smoking as teenagers (i.e., adding together the teen smokers and teen/young adult smokers), almost two-thirds of them (63 percent) also reported smoking as young adults. This together with the aforementioned findings about the proportion of new daily smokers relative to repeat daily smokers at the various survey waves suggest that there is a degree of persistence in smoking behavior. These results are also fairly consistent with prior research showing that about half (53 percent) of adult smokers in the United States became regular smokers before age 18 (U.S. Department of Health and Human Services 1994).

Examining the four developmental patterns with respect to various descriptive characteristics, it was found that there were more nondaily smokers among individuals who were younger as eighth-graders (i.e., those about 13 to 14 years old) than among their older peers (i.e., those about 15 to 16 years old in eighth grade) (71 vs. 60 percent). Likewise, fewer of the younger individuals were teen/young adult smokers compared to the older individuals (12 vs. 21 percent), although no difference by age was detected for the late-onset smokers. Together, these findings suggest that the younger individuals did not “catch up” with the older individuals in their incidence of daily smoking as tracked during the survey period. It should also be noted that many of the older individuals are those

who have had to repeat a grade. As prior research (e.g., Bryant et al. 2000; Ellickson et al. 1998; Mensch and Kandel 1988; Schulenberg et al. 1994; White, Pandina, and Chen 2002) and the current analysis indicate, adolescent smoking is associated with lower academic achievement. The present set of results indicates that daily teen-age smoking (including both groups—teen smokers and teen/young adult smokers) was more prevalent among students with lower achievement scores, with lower grades, and not participating in an academic program in high school. In the current analysis, these relationships—between smoking and age and between smoking and academic achievement—were generally found even when controlling for each other and for various individual, family, and school characteristics, including race/ethnicity, socioeconomic status (SES), family composition, and school type.

Results also show that in addition to age and academic achievement, most of the characteristics that were related to daily smoking in the set of bivariate analyses were also significant in the multivariate analysis. For example, the multivariate analysis indicates that individuals were more likely to be teen/young adult smokers than nondaily smokers if they were from a family with a lower SES or if they were from a single-parent or one-parent/one other guardian family rather than a two-parent family. In regards to race/ethnicity, Whites and Native Americans were more likely than Asians, Blacks, and Hispanics to be teen/young adult smokers as opposed to nondaily smokers. With respect to school type, students from public schools and Catholic schools were more likely than those from non-Catholic private schools to be teen/young adult smokers as opposed to nondaily smokers.

Taken together, the results show that all of the descriptive characteristics were related to smoking at some level as considered in this analysis. However, these relationships—especially those pertaining to school and academic achievement—were most consistently found for the teen/young adult smokers. That is, these relationships were most often found for those individuals who smoked regularly and with some degree of consistency beginning in the adolescent years. By the same token, this pattern of differences was generally not found for the late-onset smokers. To some extent, this reflects the fact that particular subgroups, such as low-SES and low-performing students, tend to start smoking earlier. But another possible explanation is that late-onset smoking is generally not associated with the characteristics examined in this analysis, but rather with a different cluster of characteristics or motivational factors that occur later in

life, such as attending college, entering the workforce, or starting a family. For example, other longitudinal research has found that smoking tends to decline following marriage and during pregnancy (Bachman et al. 1997).

Identifying distinct patterns of smoking and understanding factors related to these patterns has implications for research and intervention, including efforts aimed at smoking prevention. However, it is important to caution that no causality can be inferred from the relationships identified in this analysis. Furthermore, even though a multivariate analysis examined the independent association of several characteristics with regular cigarette smoking, this analysis did not consider more complex interdependencies that may exist among these characteristics, such as one variable mediating the relationship between another variable and smoking. In addition, the list of characteristics included in the multivariate analysis was limited. Therefore, it is possible that some of these relationships could be explained by accounting for additional variables—some of which may be contained in the NELS data files and some of which may not be. For example, as previously noted, the relationship between smoking and age was found even when controlling for academic achievement. However, the achievement measures in this analysis focused on the middle school years. Thus, the extent to which academic success earlier on in one's education can account for the relationship between smoking and age is not specifically known. Another variable that, although not measured in NELS, has been looked at in other studies on smoking is risk perception. For example, some research suggests that young people tend to underestimate the health risks associated with smoking and overestimate people's ability to quit smoking (Jamieson and Romer 2001a, 2001b). Furthermore, risk perception has been shown to be associated with smoking (Chassin et al. 2000; Orlando et al. 2004)—especially the decision to stop smoking (Romer and Jamieson 2001).

Future research using NELS and other datasets might further examine these and other characteristics. Using longitudinal data, these characteristics can be examined at multiple time points, linking the timeframes of various characteristics with the onset and quitting of smoking. Other analytic strategies might also be employed, such as growth mixture modeling that has recently been used in other longitudinal studies on smoking (e.g., Colder et al. 2001; Orlando et al. 2004; White, Pandina, and Chen 2002). Additional research may offer further insight, for example, into why some adolescents and young adults seem to quit smoking while others do not, and why some avoid smoking altogether whereas others take up smoking later on.

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Technical Appendix

Survey Design and Methodology

Overview. Initiated in 1988 as the third in a series of decade-long secondary school longitudinal studies by the National Center for Education Statistics (NCES), the National Education Longitudinal Study of 1988 (NELS:88) was the most ambitious secondary education longitudinal study ever undertaken by NCES. It extended the age and grade span of earlier NCES secondary school longitudinal studies by collecting data from a middle school/junior high school cohort, the eighth-grade class of 1988. There were four follow-ups—in 1990, 1992, 1994, and most recently in 2000 when most sample members turned 26 years old and typically were 8 years removed from high school enrollment. The sample was “freshened” at each of the first two follow-ups,⁸ generating nationally representative 10th- and 12th-grade cohorts, respectively. Thus, the study identifies and follows an 8th-, 10th-, and 12th-grade

⁸The process referred to here as “freshening” added students who were not in the base-year sampling frame, either because they were not in the country or because they were not in eighth grade in the spring term of 1988. The 1990 freshening process provided a representative sample of students enrolled in 10th grade in the spring of 1990. The 1992 freshening process provided a similar sample of 12th-grade students in the spring of 1992.

cohort over time, allowing for cross-sectional and longitudinal analyses with these groups. The analysis population for this report was the original eighth-grade cohort.

Along with student surveys, NELS:88 collected surveys from parents, teachers, and school administrators. Also administered to the students were cognitive tests in reading, mathematics, science, and social studies. High school transcript data were collected in the fall of 1992 and postsecondary education transcript data were collected from September 2000 through March 2001. The most recent follow-up focused on educational and labor market processes and transitions experienced by young adults. Interview topics included experiences with postsecondary education, labor market participation, job-related training, community integration, and marriage and family formation.

Response rates. The analyses in this report include respondents from the base year and all subsequent survey time points. The NELS:88 base-year sample was drawn in two stages—first schools and then students. Data from students at 1,052 schools appear on the NELS:88 base-year data files, with about 70 percent of the initial sample of schools selected for the study participating. A bias analysis was conducted comparing schools that participated to those that declined to participate; minimal bias was found (Spencer et al. 1990). The base-year student questionnaire was completed by 24,599 students, for a weighted unit response rate of 93 percent. The weighted unit response rates for the student questionnaire at the four subsequent follow-ups were 91, 91, 91, and 83 percent, respectively.

In considering response rates, it is important to note that while school-level and individual-level response rates are often considered separately, effects of nonresponse in a two-stage sample are for many purposes multiplicative across the two stages. A true indication of the response rate for students can be computed by multiplying school participation rates by individual participation rates. Thus, for example, by defining school participation in terms of the percentage of originally selected schools that agreed to participate in the study, and multiplying that percentage by the response rate for students in the base year, one derives an overall response rate of about 65 percent ($.697 \times .9341 = .651$) for students and about 69 percent ($.697 \times .9892 = .689$) for school administrators (Spencer et al. 1990). A low overall response rate does not always indicate substantial bias, however. In NELS:88, with a 70 percent school response rate and student response rates at each survey wave between 83 and 93 percent, the

biggest possible contributor to nonresponse bias is that introduced on the part of nonparticipating schools. However, as previously noted, a nonresponse bias analysis performed on schools not participating in the study found minimal bias. On average, estimates tainted by school nonresponse were found to differ from those not tainted by school nonresponse by about 4.5 percent (Spencer et al. 1990).

A more comprehensive account of response rates, including breakdowns by selected respondent subgroups such as sex, race/ethnicity, and high school enrollment or completion status, can be found in Curtin et al. (2002).

Weighting and selected sample. NELS:88 employs a complex sampling design that involves stratification, the disproportionate sampling of certain strata (e.g., private school students and some minority students oversampled), and clustered (i.e., multistage) probability sampling. Therefore, each participant may be selected with a different probability. This is in contrast to a simple random sample design where each case is selected with an equal probability of selection. To account for this unequal probability of selection and thus produce unbiased estimates, the use of sampling weights is necessary. The sampling weights also adjust for the effects of nonresponse.

The estimates in this report were produced using F4PNLWT, the panel weight for eighth-grade members of the NELS:88 sample who also participated in the first, second, third, and fourth follow-ups. The unweighted sample size was 10,827 cases representing approximately 2.9 million members of the eighth-grade class of 1988 12 years later. This is somewhat smaller than the original weighted sample of just over 3 million members of the eighth-grade class of 1988 in the base year. This shrinkage in the target population between 1988 and 2000 is due to a variety of factors. These include the loss to the population owing to mortality, being unavailable for interview by virtue of being out of the country, or, in the 2000 round only, being incarcerated or institutionalized. All of these factors have the effect of numerically reducing the target population.

Survey standard errors. Also as a result of the complex sampling design of NELS:88, the resulting statistics are more variable than they would have been had they been based on data from a simple random sample of the same size. Several procedures and statistical software packages are available for calculating precise estimates of sampling errors for complex samples. The analyses carried out in this report used the Taylor Series procedure to

calculate standard errors. They were done using the AM statistical software package, a product of the American Institutes for Research. AM is available for free download at <http://am.air.org> or on the NELS 1988–2000 CD-ROM that is available from NCES (see <http://nces.ed.gov/surveys/nels88>).

Data limitations. As with any study, there are limitations to NELS:88 that the researcher should take into consideration. First, there are design constraints. For example, the sampling frame was limited to regular public and private schools in the 50 states and the District of Columbia, and just over 5 percent of the potential base-year sample was excluded because of serious disability or greatly limited proficiency in English. (For more information about the NELS:88 base-year sample, and for a discussion of issues of eligibility, inclusion, and the effect of exclusion on national estimates, see Spencer et al. 1990 and Ingels 1996.) Second, there are limitations of the data (e.g., small cell sizes for certain groups of individuals that will produce large standard errors). There are also specific limitations of the data relevant to this analysis. For example, a number of the items, such as school grades, were self-report, and no information on smoking behavior was asked at the 1994 survey wave.

Further details about study limitations as well as further information about the methodology, design, and data contents of NELS:88 can be found in Curtin et al. (2002). A discussion about the research potential of NELS:88 can be found in Ingels et al. (2002). Both of these reports are available through the NCES website at <http://nces.ed.gov/surveys/nels88>.

Variables Used in Analysis

All variables used in this analysis were obtained or derived from the NELS 1988–2000 Electronic Codebook System: Base year through fourth follow-up ECB/CD-ROM, public use (NCES 2002).

Smoking. Four items assessing smoking behavior were used, each from a different survey wave: BYS43 (1988, base year), F1S77 (1990, first follow-up), F2S80 (1992, second follow-up), and F4ISMOKE (2000, fourth follow-up). For each item, individuals were asked, “How many cigarettes do you usually smoke in a day?” Choices included: “I don’t smoke,” “less than one cigarette a day” (except not a response choice in the base year), “1–5 cigarettes a day,” “about a half a pack a day,” “more than half and less than 2 packs a day,” and “2 or more packs a day.” Those who checked the response choice of “I don’t

smoke” or “less than one cigarette a day” were classified as nondaily smokers at that survey wave, whereas those checking any of the other levels of smoking were classified as smokers.

Response rates (weighted⁹) for the items at the four survey waves are 98, 89, 82, and 98 percent, respectively.

Using the information about individuals’ smoking behavior at the four survey waves, a separate variable was created consisting of several specific developmental patterns. These four derived patterns are as follows:

- *Nondaily smokers* included those who reported usually smoking not at all or less than one cigarette per day at each of the applicable survey waves (1988, 1990, 1992, and 2000). Also included in this category were 87 cases (unweighted) with missing data at the 1988 survey wave but that reported not smoking daily at the latter three applicable survey waves (1990, 1992, and 2000), and 324 cases (unweighted) with missing data at the 1990 survey wave but that reported not smoking daily at the first, third, and fourth applicable survey waves (1988, 1992, and 2000). These cases accounted for 2 and 5 percent, respectively, of the nondaily smokers. Analyses revealed that the probability of individuals with either of these two patterns being a nondaily smoker at all four survey waves was greater than .95, even across all subgroups by sex, race/ethnicity, and SES.
- *Teen smokers* included those who reported usually smoking one or more cigarettes per day at either of the first three survey waves (1988, 1990, or 1992) but not at the last survey wave in 2000.¹⁰
- *Teen/young adult smokers* included those who reported usually smoking one or more cigarettes per day at either of the first three survey waves (1988, 1990, or 1992) and at the last survey wave in 2000.
- *Late-onset smokers* included those who reported usually smoking one or more cigarettes per day at

⁹This weight is adjusted for nonresponse; it corrects for unit nonresponse at both stages of sampling—schools (stage 1) and students (stage 2).

¹⁰Some may have smoked cigarettes even daily beyond the teenage years and into their early twenties. But for the purpose of this analysis, they are referred to as “teen smokers” for ease of reference and to distinguish them from “teen/young adult smokers” (the next pattern to be defined). Unlike the teen/young adult smokers, the teen smokers did not report daily smoking when in their mid-twenties.

the last survey wave in 2000 but not at any of the prior survey waves (1988, 1990, and 1992).¹¹ Also included in this category were 14 cases (unweighted) with missing data at the 1988 survey wave, but that reported not smoking daily at the 1990 and 1992 survey waves and that reported smoking at the 2000 survey wave. These cases accounted for 1 percent of the late-onset smokers. Analyses revealed that the probability of individuals with this pattern being a late-onset smoker was greater than .95, even across all subgroups by sex, race/ethnicity, and SES.

Data for this derived variable were obtained for 85 percent of individuals (weighted¹²) in the sample cohort. The other 15 percent reported daily smoking or nondaily smoking at one or more survey waves, but had missing data at various survey waves that precluded their classification into one of the four categories.

Interpretation of the results presented in this report should be considered in light of potential bias surrounding missing or unclassified cases not used in the analysis. In particular, there were missing data for 18 percent of cases on the smoking item asked at the second follow-up in 1992, and 15 percent of cases were unable to be classified into one of the four developmental patterns. Two bias analyses were performed: one comparing respondents and nonrespondents on the smoking item asked at the second follow-up in 1992, and a second one comparing classified and unclassified cases for the developmental patterns. These bias analyses compared both groups along several key demographic characteristics—sex, race/ethnicity, SES, and most recent high school program. A very similar pattern of results appeared in both sets of analyses. With the exception of sex, a number of differences were found along these characteristics. In regard to most recent high school program, nonrespondents/those unclassified were less likely to be from academic high school programs (27 and 36 percent, respectively) than respondents/those classified (72 and 69 percent, respectively). Nonrespondents/those unclassified were more likely to be from other (nonvocational) high school programs (66 and 56 percent, respectively) than respondents/those classified (21 and 24 percent, respectively). With respect to race/ethnicity, nonrespondents/those unclassified

were more likely to be Black (16 and 21 percent, respectively) than respondents/those classified (11 percent for both), more likely to be Hispanic (17 and 18 percent, respectively) than respondents/those classified (9 percent for both), and less likely to be White (63 and 55 percent, respectively) than respondents/those classified (74 and 75 percent, respectively). In regard to SES, nonrespondents/those unclassified were more likely to be from low-SES families (44 and 43 percent, respectively) than respondents/those classified (19 percent for both); likewise, nonrespondents/those unclassified were less likely to be from high-SES families (10 and 12 percent, respectively) than respondents/those classified (31 and 30 percent, respectively). In addition, those unclassified into the smoking patterns were less likely to be from middle-SES families (45 percent) than those classified (51 percent).

In separate analyses of just the nonrespondents/those unclassified by race/ethnicity and SES jointly, it was found that about one-third were middle-income Whites (35 and 31 percent, respectively). Nonrespondents/those unclassified were more likely to be middle-income Whites than all other race/ethnicity and SES combinations, including low-income Whites (21 and 16 percent, respectively), low-income Blacks (9 and 13 percent, respectively), low-income Hispanics (12 and 13 percent, respectively), and high-income Whites (7 and 8 percent, respectively).

Descriptive characteristics. This information was obtained from variables available on the NELS 1988–2000 public-use ECB/CD-ROM (NCES 2002) as follows:

- Respondent's **sex** was obtained from the composite variable F4SEX.
- Respondent's **race/ethnicity** was obtained from the composite variable F4RACE.
- Respondent's **age** was obtained from the composite variable BIRTHYR.
- **Socioeconomic status (SES)**, as shown in table 2, was derived from the composite variable F2SES1Q, a quartile coding of the composite variable F2SES1. F2SES1, as used in the regression analysis shown in table 3, provides an SES scale score for each individual that is derived from the following parent-questionnaire data obtained in the base year: father's education level, mother's education level, father's occupation, mother's occupation, and family income.

¹¹Some may have been smoking daily as early as the late teenage years (e.g., sometime after the 12th grade). But for the purpose of this analysis, they are referred to as "late-onset smokers" for ease of reference and to distinguish them from the "teen smokers" and "teen/young adult smokers."

¹²This weight is adjusted for nonresponse; it corrects for unit nonresponse at both stages of sampling—schools (stage 1) and students (stage 2).

- **Family composition** was obtained from the composite variable BYFCOMP. For this analysis, four categories were created from the ones in BYFCOMP: *two parents*, which consists of “mother and father,” *one parent and other guardian*, which includes the categories of “mother and male guardian” and “father and female guardian,” *single parent*, which includes the categories of “mother only” and “father only,” and *other*, which consists of “other relative or non-relative.”
- **Achievement scores** consist of a combined reading and math standardized test score. As shown in table 2, these were obtained from the composite variable BY2XQURT. This is a quartile distribution of the composite variable BY2XCOMP, a continuous variable that was used in the regression analysis shown in table 3.
- **Student-reported grades**, as shown in table 2, were obtained from the composite variable BYGRADSQ. This is the quartile distribution of the composite variable BYGRADS. It was constructed by recoding BYGRADS into quartiles based on the weighted, using BYQWT, marginal distribution. BYGRADS is an average, with all nonmissing elements equally weighted, of the self-reports for grades over the following four subject areas: English, mathematics, science, and social studies. Eighth-graders were asked to describe their grades in each of these subject areas from grade 6 up until the time of data collection (i.e., spring of eighth grade). BYGRADS, as used in the regression analysis shown in table 3, was computed by converting the response categories in these subject areas to a five-point scale (i.e., mostly As = 4.0, mostly Bs=3.0, mostly Cs = 2.0, mostly Ds = 1.0, and mostly below D = 0.5) and taking the mean of all nonmissing values of these four variables equally weighted.
- **Type of school attended in eighth grade** was derived from the composite variable G8CTRL1, which classifies the eighth-graders’ schools as either public, Catholic, other religious, or nonsectarian private school. Due to small sample sizes, these latter two categories were combined into one category, “other private,” in this analysis.

- **After eighth grade, high school program participation** was obtained from the composite variable F3HSProg. It refers to the type of high school program an individual participated in at his/her last high school. If this information was collected in the 1992 transcript study for a respondent, then the 1992 data were used. If 1992 transcript data were not collected, then 1994 questionnaire data were used. If neither were available, then 1992 questionnaire data were used.

For all of the above descriptive characteristics, data were obtained from between 96 and 100 percent of individuals in the sample cohort.

Further information about the variables and composite variables used in this analysis can be found in the NELS 1988–2000 public-use ECB/CD-ROM (see <http://nces.ed.gov/surveys/nels88>) or the respective NELS:88 data file user’s manual (see Curtin et al. 2002).

Statistical Tests

Bivariate analyses. Comparisons that have been drawn in the text of this report have been tested for statistical significance to ensure that the differences are larger than those that might be expected due to sampling variation. The statistical comparisons in this report were based on the *t* statistic. Whether the statistical test is considered significant or not is determined by calculating a *t* value for the difference between a pair of means or proportions and comparing this value to published tables of values, called critical values. The alpha level is an *a priori* statement of the probability that a difference exists in fact rather than by chance. All of the differences cited in this report are significant at the .05 level of significance, meaning that for any given comparison there is a 5 percent chance that an observed significant difference may be due to chance.

The *t* statistic between estimates from various subgroups presented in table 2 can be computed by using the following formula:

$$t = \frac{x_1 - x_2}{\sqrt{(SE_1^2 + SE_2^2)}}$$

where x_1 and x_2 are the estimates to be compared (e.g., the means of sample members in two groups) and SE_1 and SE_2 are their corresponding standard errors.

Some of the tests using estimates in table 1 compared related groups. To account for this sample dependency, the t statistic for dependent samples was computed using the following formula:

$$t = \frac{x_1 - x_2}{\sqrt{(SE_1^2 + SE_2^2) + 2(SE_1)(SE_2)}}$$

Multivariate analysis. A multinomial logistic regression analysis examines the unique relationship between each independent variable on a categorical dependent variable by controlling for all other independent variables in the regression. In this analysis, smoking status was the dependent variable, with the three smoking patterns (i.e., teen smokers, teen/young adult smokers, and late-onset smokers) examined in relation to nondaily smokers (the reference group). All of the descriptive variables in table 2 were entered into the regression analysis. Table 3 shows the estimated coefficients (B) and related statistics from the regression. Whereas SES, achievement scores, and student-reported grades were entered into the regression as continuous variables, all of the other independent variables were entered in as dummy-coded categorical variables. The coefficient for a given categorical variable is expressed in relation to the omitted category for that variable, controlling for all other variables in the regression.

Acknowledgments

The author wishes to thank the many individuals who provided assistance with this report. Several people provided valuable analytical suggestions or other helpful comments pertaining to the writing of the report, including: Drew Malizio, Jeff Owings, Tai Phan, Marilyn Seastrom, and Jerry West, all from NCES; Karen O’Conor, formerly with NCES and now with the United States General

Accounting Office (GAO); Lisa Bridges, Ivor Pritchard, and Grover Whitehurst of the Institute of Education Sciences; Bill Modzeleski from the Office of Safe and Drug Free Schools; Carolyn Lee from the Office of Vocational and Adult Education; Jerry Bachman from the University of Michigan, Institute for Social Research; Charlotte Schoenborn from the Centers for Disease Control and Prevention, National Center for Health Statistics; Steven Ingels from the Research Triangle Institute; my colleagues from the Education Statistics Services Institute (ESSI) of the American Institutes for Research (AIR), Mike Planty, Leslie Scott, and Zeyu Xu; and two anonymous reviewers. Appreciation is also extended to Kristy David and Lisette Partelow of ESSI for technical assistance, to Peggy Quinn at NCES for administrative assistance with the review process, to Robin Gurley and Martin Hahn at ESSI for editorial assistance, and to Heather Block and Jennie Jbara of the Communications Design Team at ESSI for final formatting of the report.

For More Information

NCES has collected secondary-school longitudinal data for 30 years. Starting in 1972 with the National Longitudinal Study of 1972 (NLS-72), and continuing to the most recent study, the Education Longitudinal Study of 2002 (ELS:2002), NCES provides longitudinal data to education policymakers and researchers that link secondary school educational experiences with important downstream outcomes like labor market experiences and postsecondary education enrollment and attainment. Readers who are interested in further information about these studies and available public-use or restricted-use data files, including the data file used in this report (i.e., NELS:88/2000 Electronic Codebook System: Base year through fourth follow-up ECB/CD-ROM, public use), should go to <http://nces.ed.gov/surveys/nels88>.