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Age-Related Differences in Cigarette Smoking Among Whites and African-Americans: Evidence for the Crossover Hypothesis*

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Abstract

Background—Age crossover describes the age-related reversal in prevalence of current cigarette smoking among non-Hispanic whites and African-Americans, with prevalence higher among whites than African-Americans in adolescence but lower in adulthood. Prior studies have examined smoking patterns in separate adolescent and adult samples and have not sought to identify factors that could account for crossover. We conducted analyses using national samples to identify factors that account for crossover and estimate their impact on crossover age.

Methods—Analyses are based on national samples of lifetime smokers 12–49 years old in three aggregated National Surveys on Drug Use and Health (N=61,757) (SAMHSA 2007–2009) and on multiple birth cohorts followed over 21 cross-sectional surveys.

Results—We identified crossover for cigarette smoking in the US population at about age 29. Crossover is partially explained by differences between whites and African-Americans in education and marital status, and more weakly by the opposite impact of age of smoking onset on persistence of smoking in the two groups. Controlling for smoking history, education and social role participation would raise crossover in current smoking by more than 14 years. Rates of current smoking among lifetime smokers at four different age categories in multiple birth cohorts followed from ages 12–17 to 35 and over in 21 surveys spanning 24 years confirm the age-related patterns observed cross-sectionally.

Conclusion—Age crossover for current smoking appears among whites and African-Americans. Efforts targeted toward improving educational levels of young people would have the strongest impact in decreasing persistent smoking, especially among African-Americans.

Keywords

age crossover; current cigarette smoking; non-Hispanic whites; non-Hispanic African-Americans; education

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1. INTRODUCTION

The Age Crossover Hypothesis, first suggested by Geronimus et al. (1993) in a study of smoking by pregnant women, describes the reversal in the prevalence of cigarette smoking among whites and African-Americans over the life cycle. In adolescence, the prevalence of smoking is higher among whites than African-Americans. At some point in adulthood, the pattern is reversed: prevalence becomes higher among African-Americans than whites (Biafora and Ziemmerman 1998; Ellickson et al., 2003; Feigelman and Lee 1995; Flint et al., 1998; Kandel, 1991; 1995; King et al., 2004; Pampel, 2008) or at least the rates of use converge (Pampel, 2008). With rare exceptions, most of what is known about racial/ethnic differences regarding life cycle differences in patterns of cigarette smoking is based upon separate adolescent and adult samples.

A sociological perspective rooted in socialization theory that emphasizes the relevance of role incompatibility, role selection and socialization on patterns of drug use over time (Kandel and Yamaguchi, 1987; Yamaguchi and Kandel, 1985a; 1985b) may help account in part for the crossover phenomenon. An individual's progression through the life course is marked by successive participation in different social roles. Participation in the traditional roles of adolescence and adulthood tends to be associated with traditional values, attitudes and behavior in various realms, including reduced use of drugs. Being a student is an important role in adolescence; being a worker, spouse, or parent are important roles in adulthood. Cross-sectional and longitudinal data suggest that conventional social roles and drug use are incompatible. In cross-sectional samples, the use of drugs is negatively related to being married, being a parent and working but positively related to being absent from school, unemployed, divorced or living with a partner (Bachman et al., 1984; Clayton and Voss, 1977; Kandel, 1984; Kandel et al., 1986; Miller and Cisin, 1980; Yuan, 2009). Education is strongly negatively related to tobacco use (Eikemo et al., 2007; House, 2002; Kiefe et al., 2001; Robert and House, 2000; Schaap et al., 2008; Schnittker and McLeod, 2005; U.S. Department of Health and Human Services 2007). Because African-American adults have lower educational attainment and are less likely than whites to be married and to be employed full-time, these disparities could account for the fact that rates of tobacco use do not decline after the mid-twenties as strongly for African-Americans as for whites.

To investigate the Age Crossover Hypothesis for cigarette smoking in the United States, we examine age-specific rates of current use of cigarettes from age 12 onward among non-Hispanic white and non-Hispanic African-American lifetime smokers in three aggregated cross-sectional surveys, 2006-2008, of the National Survey on Drug Use and Health (NSDUH). We attempt to identify the factors that account for the differential age-related patterns observed among whites and African-Americans and how these factors impact on the ages at which crossover appears. Relevant factors will shift upwards the age at which crossover is estimated to occur. Age comparisons based on cross-sectional data potentially confound age related differences due to natural changes with birth cohort differences and historical factors. To partially overcome the limitations of the cross-sectional sample, we also report descriptive analyses based on data from multiple consecutive cross-sectional national surveys. In any particular year, and in successive surveys, members of a particular birth cohort are representative of the age groups from that cohort at the time of the interview. Thus, to approximate longitudinal cohorts, we examine rates of current cigarette smoking reported by different birth cohorts at different ages when followed over time in 21 successive national surveys, spanning 24 years, from the National Household Survey on Drug Abuse (NHSDA) for years 1985-2001 and the National Survey on Drug Use and Health (NSDUH) for years 2002-2008, conducted by the Substance Abuse and Mental Health Service Administration (SAMHSA).

2. METHODS

2.1. The Data

We examined the use of cigarettes among individuals aged 12-49 in the NSDUH and the antecedent NHSDA. These annual cross-sectional national surveys of the US population 12 years old and over provide data for individuals at different stages of the life cycle. The target civilian non-institutionalized population represents over 98% of the total population, including persons living in non-institutionalized group quarters, such as homeless shelters, rooming houses and college dormitories. Individuals on active military duty, in jail or drug treatment programs and the homeless not in shelters are excluded. The same measures have been used for adolescents and adults.

The multivariate analyses, where we estimate the crossover age, are based on data from the three aggregated NSDUH 2006-2008 surveys (SAMHSA 2007-9), in which youths 12-25 years old were over-sampled. Respondents were administered computer-assisted structured personal household interviews and asked about their use of tobacco. The completion rates were 67.2%, 66.1% and 66.3%, respectively. Weights take into account the stratified multistage cluster sampling design and correct for over-sampling and non-response rates so that the resulting weighted samples are representative of the U.S. population. The analytical sample includes lifetime white and African-American smokers 12-49 years old from the three surveys. Because samples for three surveys were combined, the weights were divided by three ($N=61,757$). Of the sample, 5.9% were 12-17 years old, 21.0% were 18-25, 24.0% were 26-34, and 49% were 35-49 years old.

In addition, the prevalence of current smoking among lifetime smokers was examined in 21 consecutive surveys conducted in 1985, 1988, and annually from 1990 to 2008 (SAMHSA 1988-2000a; 2000b and 2001; 2002; 2003-2006; 2007-2009) over 24 years to approximate longitudinal panels (See Section 3.4).

2.2. Multivariate Statistical Analysis

We implemented a statistical approach used by Ross and Bird (1994) to account for age-related differences in perceived quality of health between men and women and to estimate the crossover point at which perceived health would be equal in the two genders. This method was also used by Yuan (2009) in her analysis of crossover in patterns of use and abuse of alcohol and illicit drugs by whites and African-Americans. The method makes it possible to specify the age at which crossover occurs for a particular event in the population studied and to estimate the crossover age after potential explanatory factors have been controlled. By including each covariate in a sequential order according to their developmental course in hierarchical logistic regressions, at each step this strategy identifies the relative importance of covariates and specifies the ages at which crossover in the event of interest would occur were the two groups equal on the selected variables. At the estimated crossover age, the rates of the behavior of interest are the same in both racial/ethnic groups. Adjusting for relevant covariates moves the estimated crossover point to older ages and may eliminate it.

We implemented this strategy to predict current smoking of cigarettes, i.e., smoking within the last month, among lifetime smokers. First, to establish crossover and the specific age when it appeared in the population, the predictors included only age, age squared (a negative coefficient reflects a decline in smoking after a certain age), and an interaction term between age squared and ethnicity to test statistically the hypothesis that the age-related decline in smoking differed between whites and African-Americans. In successive steps, individual factors hypothesized to affect the crossover age were added: age of onset into cigarette smoking, the interaction between onset age and race/ethnicity, gender, education and social

role participation (work and marital status). At each step, the age at which the rates of smoking were equal in the two racial/ethnic groups were estimated. Control for the various factors made it possible to estimate the crossover point assuming that the two racial/ethnic groups were equal on these variables.

The equation modeling the effects of racial/ethnicity on cigarette smoking related to age is:

$$y = b_0 + b_1 (\text{African-American}) + b_2 (\text{age}) + b_3 (\text{age}^2) + b_4 (\text{African-American} \times \text{age}^2) \quad (1)$$

The smoking rate for whites is:

$$y_{\text{white}} = b_0 + b_2 (\text{age}) + b_3 (\text{age}^2) \quad (2)$$

The smoking rate for African-Americans is:

$$y_{\text{African-American}} = (b_0 + b_1) + b_2 (\text{age}) + (b_3 + b_4) \times (\text{age}^2) \quad (3)$$

The age at which the smoking rates among whites and African-Americans would be the same was estimated by setting equations for each group [Equations (2) and (3)] to be equal.

$$\begin{aligned} b_0 + b_2 (\text{age}) + b_3 (\text{age}^2) &= (b_0 + b_1) + b_2 (\text{age}) + (b_3 + b_4) \times (\text{age}^2) \\ b_0 - b_0 - b_1 &= (b_2 - b_2) (\text{age}) + (b_3 + b_4 - b_3) \times (\text{age}^2) \\ -b_1 &= b_4 (\text{age}^2) \\ -b_1 / b_4 &= (\text{age}^2) \\ \sqrt{-\frac{b_1}{b_4}} &= \text{crossover age} \end{aligned} \quad (4)$$

Models were estimated with the SURVEYLOGISTIC procedure in SAS.9.2 (2009).

2.3 Variables

Sex: male=1; female=2

Age: years. Only grouped ages available on the public use data as of age 22, to which we assigned mid-point values: ages 22-23=22.5; 24-25=24.5; 26-29=27.5; 30-34=32; 35-49=42.

Lifetime smoking: ever smoked part or all of a cigarette 1=yes; 0=no

Current smoking: smoked last 30 days 1=yes, 0=no

Onset age into smoking: years

Labor force participation; marital status: see categories in Table 1. Not ascertained among respondents 12-14 years old, who were coded as a separate category.

Education: less than high school, high school graduate, some college, college graduate, age 12-17.

3. RESULTS

3.1. Racial/Ethnic Specific Patterns of Cigarette Smoking

Lifetime rates of cigarette smoking in the total population at each age are consistently higher among whites than African-Americans (Figure 1). Thus, at ages 35-49 in 2006-2008, the proportions having ever smoked cigarettes are 79.3% for whites and 59.9% for African-Americans ($p<.001$). Age-related patterns in smoking in the two racial/ethnic groups, however, are quite different for current use (last 30 days) among those who ever smoked. These conditional rates index persistence of use. We examined current cigarette smoking in four age groups from adolescence to age 49: ages 12-17, 18-25, 26-34, and 35-49, the periods of highest cigarette use in the population (Figure 2). Crossover appears between ages 18-25 and 26-34. Prior to these ages, prevalence is higher for whites than African-Americans; as of these ages, prevalence is higher for African-Americans than whites.

3.2. Age of Onset and Persistence of Cigarette Smoking

The crossover pattern in conditional rates of current cigarette smoking observed among white and African-American adults is paradoxical. Indeed, age of onset into smoking is higher for African-Americans (16.1 years, $SD=3.8$) than whites (15.0 years, $SD=3.5$, difference between groups significant at $p<.001$). Among smokers aged 12-49, African-Americans initiate cigarette use about 13 months later than whites. Analyses conducted in national samples and other samples undifferentiated as to race/ethnicity find that later onset into cigarette smoking is protective. Later onset is related to less chronic and less extensive smoking and to lower levels of dependence (Breslau and Paterson, 1996; Chen et al., 2009; Giovino, 1999; Grant and Dawson, 1998; Kandel, 2003; King and Chassin, 2007; Substance Abuse and Mental Health Services Administration, 2005; Yamaguchi and Kandel, 1984). Yet, African-Americans, who initiate the use of cigarettes later than whites, are more likely than whites to continue to smoke in adulthood.

The paradox is partially resolved when the association between age of onset into cigarette use and current smoking among lifetime smokers is examined separately among whites and African-Americans (Figure 3). Among whites, as expected, persistence of smoking **decreases** with increasing age of onset, as of age 14. By contrast, among African-Americans, persistence of smoking **increases** regularly with increasing age of onset. As of onset age 14, the rates of persistent smoking are consistently higher among African-Americans than whites. Onset age into cigarettes has opposite effects on persistence of use among African-American and white cigarette smokers.

3.3. Explaining the Crossover Phenomenon in Smoking

The crossover curves for smoking illustrate that, while African-American youths start with an advantage, this advantage fails to persist later in adulthood. The factors that come into play for whites do not appear to do so for African-Americans. The opposite relationship between later age of onset and persistence of cigarette smoking among whites and African-Americans may partially explain crossover in smoking.

Differences in socioeconomic resources and social role participation between whites and African-Americans may also contribute to the age-related differential in patterns of smoking between the two groups (Table 1). African-Americans have lower education and are less likely than whites to participate in the traditional roles of adulthood. Twice as many whites as African-Americans are college graduates and almost twice as many are married. The proportion working is higher among whites than African-Americans, while the proportion disabled, retired or with no job is almost twice as high among African-Americans as whites.

To test the hypothesis that the combined impact of the inverse relationship between onset age and persistence of cigarette smoking and the disparity in education and social roles between whites and African-Americans could explain the crossover, hierarchical logistic regressions were estimated, as described in Methods. Sociodemographic characteristics, education, and participation in social roles were entered sequentially according to their modal sequence in the population: education, followed by labor force participation, and marital status. Table 2 displays the exponentiated beta coefficients, i.e., adjusted odds ratios, of these predictors of smoking. The first regression (Model 1) displays the effects of race/ethnicity, age, age squared, and the interaction of race/ethnicity and age squared on current smoking. The interaction term tests the hypothesis that African-Americans are more likely to smoke than whites at older ages. Model 1 indicates that African-Americans are indeed less likely to be current smokers than whites, as reflected in the odds ratio for race/ethnicity. But this advantage decreases with age, as reflected in the negative effect of age squared for whites (smoking initially increases with age but as of a certain age starts to decrease), and the positive race/ethnicity interaction with age squared. At younger ages, African-Americans are less likely to smoke than whites but after a certain age they are more likely to do so. Based on the estimation procedure outlined in Section 2.2, the estimated crossover age at which rates of smoking for whites and African-Americans are the same is 28.8 years, taking into account only age, age squared, race/ethnicity, and the interaction between the latter two factors. As per step (4) of the formula on p.8-9, the initial estimated crossover age in Model 1 is obtained by taking the logarithms of the coefficients in Table 2, calculated to six decimals rather than the three shown in the table.

- b_1 (coefficient for African-American) = logarithm of 0.619155 = -0.4794
- b_4 (coefficient for interaction between African-American and age squared) = logarithm of 1.000579 = 0.000579
- $$\text{Crossover Age} = \sqrt{-\frac{b_1}{b_4}} = \sqrt{-\frac{-0.4794}{0.000579}} = \sqrt{827.9793} = 28.77$$

Model 2 adds gender to the model. Gender has a negative impact on current cigarette smoking but does not affect the race/ethnic differential.

Model 3 adds age of cigarette onset and the interaction with race/ethnicity. As noted above, age of cigarette onset is negatively related to persistence of cigarette smoking for whites; the interaction is positive, indicating that as age of smoking onset increases, African-Americans are more likely to smoke than whites. However, controlling for age of onset into smoking and the interaction with race/ethnicity increases the estimated age of crossover only slightly by .8 years to age 29.6.

Model 4 adds education to the model. Education is significantly negatively related to current cigarette smoking. Compared with not having graduated from high school, each increasing educational level, from high school graduation, to some college, and to college graduation, almost doubles the reduction in levels of current smoking. The estimated crossover age, assuming that the educational levels of African-Americans would match those of whites, would be 36.5 years. Adjusting for education (after adjusting for age, race/ethnicity, gender and age of smoking onset) raises the estimated crossover age by almost seven (6.9) years.

Model 5 adds the work status variables. Compared with those in the labor force, those who are keeping house full time are less likely to be currently smoking while those with no job or who are retired or disabled are more likely to be smoking currently. However, the work status variables affects the estimated crossover age only by about eleven months.

Model 6 adds the marital status variables. Compared with those who are married, those who are separated, divorced or never married are more likely to be current smokers. Additional control for marital status has a large impact. The expected crossover age increases by 5.7 years.

Overall, controlling for age of smoking onset, the interaction between age of smoking onset and race/ethnicity, gender, education, and social role participation in work and marriage increases the crossover age by 14.3 years from age 28.8 to age 43.1.

3.4. How Real a Phenomenon is Crossover in Cigarette Smoking?

A limitation of the analysis is that it is based on cross-sectional data and therefore the individuals being compared at different ages belong to different birth cohorts. As noted earlier, the age comparisons may not reflect true maturational changes, since cross-sectional age differences confound developmental changes with cohort differences and historical factors. The optimal documentation would be based on one or more longitudinal panels spanning adolescence to adulthood.

We approximated such longitudinal cohorts by examining repeated cross-sectional data from multiple waves of the NHSDA/NSDUH, where the behavior of the same national birth cohorts could be followed over time, since each annual sample includes random subsamples of the same birth cohorts. We examined the rates of current cigarette smoking among white and African-American lifetime smokers in different birth cohorts as they aged by following the cohorts in 21 successive surveys for up to 24 years. We used data from the NHSDA for the years 1985, 1988, 1990-2001 (SAMHSA 1988-2000a; 2000b and 2001; 2002) and the NSDUH for the years 2002-2008 (SAMHSA 2003-2006; 2007-2009). Annual surveys were implemented as of 1990. We used published reports for the years 1985-1998 and computer files for years 1999-2008 (SAMHSA 2002-2006; 2007; 2009a;b). The available data constrained the comparisons that could be made. Published data present rates of smoking for four aggregated age categories that include multiple birth cohorts, six at ages 12-17, eight at ages 18-25, nine at ages 26-34, plus an indeterminate number among those 35 years old and over. Furthermore, since 1999 data are provided for grouped rather than single ages as of age 22. As a result, age comparisons can only be based on sets of six birth cohorts. The behavior of aggregated cohorts can be followed by selecting the surveys conducted six years, 14 years and 23 years after the initial surveys when respondents were 12-17 years old. Because of unequal age ranges in the four grouped age classes, as of ages 18-25, each grouped category includes a larger number of cohorts than were included in the initial 12-17 age groups. Consequently, at each time period, only the youngest six cohorts correspond to the initial cohorts selected at ages 12-17 and are aged 18-23, 26-31 and 35-40 years, respectively. Table 3 follows each cohort group over time and displays the available data points horizontally. Only the 1968-73 birth cohorts, first interviewed at ages 12-17 in 1985, have data for all four age categories; the other cohorts have data for one, two or three age-groups. Some cohorts have data as of ages 18-25, but are left-censored and are missing data for ages 12-17. Other cohorts are right censored and do not have data beyond ages 12-17 or 26-34. For ease of comparison, the ages at which rates of smoking are higher among African-Americans than whites are shaded in Table 3. The four relevant data points for the 1968-1973 birth cohorts are plotted in Figure 4. In these birth cohorts, whites have higher rates of smoking than African-Americans in adolescence and early adulthood; crossover occurs between ages 26-34 and 35+, later than was observed cross-sectionally for survey years 2006-2008.

The patterns observed for the truncated cohorts are consonant with the Age Crossover Hypothesis. As predicted, the rates of smoking are higher among whites than African-Americans in adolescence (ages 12-17) for 19 of the 21 aggregated birth cohorts. Thirteen

cohort groups (birth years 62 to 82) span the ages 18 to 34 (Survey years 1985-2000). The rates become higher among African-Americans than whites as of ages 26-34 in six of these 13 cohorts. Crossover appears earlier at ages 18-25 for two cohort groups, and later at ages 35 and over for one cohort group. Four cohorts are right censored. In 15 of the 21 cohorts surveyed at ages 26-34, rates of smoking are higher among African-Americans than whites, not taking into account their prior or subsequent behaviors. Despite their limitations, these approximated and truncated longitudinal data support the conclusion that crossover occurs prior to age 35 in the majority of cases over an historical period spanning 24 years. By ages 35-49, smoking rates among African-Americans are consistently higher than among whites.

Thus, crossover in persistence of smoking is observed not only in the age-specific cross-sectional data for the years 2006-2008, but in the multiple birth cohorts that can be followed across 24 years from 1985 to 2008. There probably are variations in the crossover age in different periods, but it appears to occur some time in the mid to late twenties or the early thirties.

4. DISCUSSION

Crossover in cigarette smoking, in which African-Americans have lower rates than whites in adolescence and early adulthood but higher rates in adulthood, is observed not for lifetime smoking but for persistence of smoking, i.e., current smoking among those who ever smoked. In the cross-sectional national sample that we analyzed, the age at which crossover is observed for smoking cigarettes is 28.8 years, not taking into account any factor except age, age squared, race/ethnicity and the interaction between age squared and race/ethnicity.

Our analyses suggest that several factors account for the race/ethnic reversal in patterns of smoking. The identification and impact of these factors was assessed in hierarchical models that estimated crossover ages in smoking rates predicated on standardizing white and African-American smokers on the explanatory variables of interest. Three factors have an impact on crossover in smoking. The most important factor is education. African-Americans have lower education than whites, which accounts for a major part of the crossover. Equal educational achievement among whites and African-Americans would delay the crossover age by close to seven years, after controlling also for age of smoking onset. The second important factor is marital status. African-Americans have much lower rates of marriage than whites. Controlling for age of onset, educational level, and labor force participation, similar rates of marriage in the two racial/ethnic groups would delay the crossover age further by close to another six years. The third factor is age of smoking onset. Unexpectedly, the relationship between persistence of smoking and age of smoking onset is opposite for white and African-American smokers. Earlier age of smoking initiation increases persistence for whites but lowers persistence for African-Americans. Among African-Americans, smoking initiation takes place about 13 months later on average than among whites. Were the ages of initiation the same among both groups, the crossover age would increase by about ten months; labor force participation does not affect crossover.

Yuan (2009) observed crossover between whites and African-Americans for last year use and abuse of alcohol, illicit drugs and prescription drugs for non-medical purposes (not restricted to lifetime users of each drug class) in another sample representative of the U.S. population. Cigarette smoking was not investigated. The effect of education was statistically significant but its impact on crossover age was not estimated separately from that of other sociodemographic factors. Similar to this study, however, there were no effects of work on the age-by-race crossover, while family related variables (being married and having a good relationship with children) increased crossover for alcohol use, alcohol abuse and drug abuse

by five years. This effect is similar to the effect of marital status observed for current smoking among lifetime smokers in this study.

Aspects of smoking history, education and social role participation together would raise crossover in current smoking by more than 14 years to age 43. This is slightly over the mid-point of the oldest age category in the sample. Thus, control for these factors seems to account completely for the crossover in current cigarette smoking observed among whites and African-Americans in this sample. While Kiefe et al. (2001) found that level of education accounted for most of the disparity in smoking rates between African-Americans and whites in a sample aged 28-40, we find strong additional contributions of marital status. Broader contextual community and societal factors were not investigated in the present study. However, we infer that the influence of such factors is mediated by the significant individual factors that we identified. The role of age of onset is particularly puzzling. To the best of our knowledge, this is the first report in the literature to highlight the potentially opposite impact of age of onset on the natural history of smoking among whites and African-Americans. The data at our disposal do not allow us to investigate why age of onset would have different consequences for current smoking among different groups. This finding needs to be replicated and explored further to understand better the determinants and consequences of age of smoking onset in different groups.

A limitation of our study is its reliance on cross-sectional data, which impacts on two issues in particular. The observed associations between participation in social roles, such as schooling and marriage, and individual behaviors, such as smoking, reflect the dynamic interaction of two processes: role selection, i.e., the influence of preexisting behaviors on the timing and sequencing of social role participation, and role socialization, i.e., the subsequent influence of social role participation on individual behaviors (Kandel and Yamaguchi, 1987; Yamaguchi and Kandel, 1985b, 1987). Longitudinal data are needed to resolve the issue.

Furthermore, as we noted earlier, the age-related differences, reflected in the crossover ages, which are based on cross-sectional data confound to some extent maturational, historical and cohort-specific effects. We tried to overcome this limitation at a descriptive level by approximating longitudinal panels in successive national surveys where we could follow the smoking behavior of the same cohorts as they aged. The fact that the same age-related patterns are observed in each of the 21 cross-sectional surveys since 1985 (except for ages 12-17 in 1997 and 1998) covering a 24-year period and in multiple birth cohorts followed over time provides some support for the conclusion that the age-related crossover observed with respect to smoking among whites and African-Americans is a real phenomenon. However, differences in crossover ages between cross-sectional samples and cohorts followed over time call attention to the fact that the specific ages at which crossover occurs may vary across historical periods. Similarly, the number of years that various factors contribute to crossover will vary. In addition, the conclusions are based on grouped data and therefore describe group patterns that may or may not apply to subgroups or individuals.

Another limitation of the study is the coding of the age variable as of the mid-point of grouped age categories for a substantial range of ages in the sample. This affected the precision of the changes in crossover ages that we estimated.

Despite these limitations, the present study provides insights into the factors that contribute to the observed crossover in rates of current smoking among whites and African-Americans and supports the emphasis of Kiefe et al. (2001) on targeting public health efforts toward reducing socioeconomic disparities between different racial/ethnic groups. The present study highlights that education, in particular, needs to be a major focus of prevention and intervention. Efforts targeted to retaining youths in school and encouraging the pursuit of

educational goals, while not explicitly targeted to reducing the uptake and persistence of smoking, would in fact do so and would have numerous additional beneficial effects for the individual and society besides its effect in reducing smoking rates. Not only would these individuals have better economic prospects and social advantages, they would be more likely not to start smoking or to stop smoking once having started to do so. Because of the well established links between smoking and the progression to illicit drugs (Kandel, 2002), individuals who did not start to smoke would also be less likely to progress to other drugs, with the additional health benefits that this entails.

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Figure 1.
Lifetime Prevalence of Smoking in the Population by Age Among non-Hispanic Whites and African-Americans (NSDUH years 2006-2008, SAMHSA 2007; 2009a;b) (N=112,026).

Figure 2. Current Smoking by Age Among Lifetime Smokers Among non-Hispanic Whites and African-Americans (NSDUH years 2006-2008, SAMHSA 2007; 2009a;b)(N=61,757).

Figure 3. Current Smoking by Age of Onset into Cigarette Use Among White and African-American Lifetime Cigarette Smokers 12-49 Years Old (NSDUH years 2006-2008, SAMHSA 2007; 2009a;b) (N=61,757).

Figure 4. Current Smoking by Age Among White and African-American Lifetime Smokers in the 1968-1973 Birth Cohorts in 1985, 1991, 1999, and 2008 (NHSDA/ NSDUH surveys, SAMHSA 1990; 1993; 2000b; 2009b) (N's: see Table 1)

Table 1

Education, work, and marital status among non-Hispanic white and African-American lifetime smokers 12-49 years old (NSDUH years 2006-2008, SAMHSA 2007; 2009a;b) (N=61,757).

	Whites (%)	African Americans (%)
Education		
less than high school	10.4	16.8 ***
high school graduate	29.0	35.6
some college	27.3	27.5
college graduate	27.5	13.0
age 12-17	5.8	7.1
Working last week		
working, has job	79.4	71.2 ***
keeping house full-time	5.4	4.0
in school/training	3.9	4.7
disabled/retired/no job	10.0	18.3
age <=14	1.3	1.8
Marital status		
married	49.6	26.5 ***
divorced/separated/widow	12.6	15.8
never married	36.5	55.9
age <=14	1.3	1.8
Total N ≥	(53,643)	(8,100)

*** Significant at $p < .001$ (Chi-Square test)

Table 2

Logistic regressions of current smoking (last month) among non-Hispanic white and African-American lifetime cigarette smokers aged 12-49 years on race, age, age squared and the interaction of age squared and race/ethnicity (Model 1), controlling for gender (Model 2), age of cigarette onset and interaction with race/ethnicity (Model 3), education (Model 4), work status (Model 5) and marital status (Model 6). (NSDUH years 2006-2008, SAMHSA 2007; 2009a;b) (N=61,757).

	Univariates			Model 1			Model 2			Model 3			Model 4			Model 5			Model 6			
	OR	95% CI		AOR	95% CI		AOR	95% CI		AOR	95% CI		AOR	95% CI		AOR	95% CI		AOR	95% CI		
Race/ethnicity ^a (African-American)	1.230	***	1.148-1.317	0.619	***	0.543-0.706	0.617	***	0.541-0.704	0.146	***	0.113-0.188	0.156	***	0.120-0.201	0.146	***	0.113-0.191	0.141	***	0.108-0.185	
Age	0.973	***	0.972-0.975	1.099	***	1.073-1.125	1.099	***	1.073-1.125	1.107	***	1.082-1.134	1.143	***	1.104-1.185	1.137	***	1.097-1.177	1.234	***	1.191-1.278	
Age ²	1.000	***	1.000-1.000	0.998	***	0.998-0.998	0.998	***	0.998-0.998	0.998	***	0.998-0.998	0.997	***	0.997-0.997	0.997	***	0.997-0.997	0.996	***	0.996-0.996	
Race/ethnicity* Age ²				1.001	***	1.001-1.001	1.001	***	1.001-1.001	1.000	***	1.000-1.000	1.001	***	1.001-1.001	1.001	***	1.001-1.001	1.000	***	1.000-1.000	
Gender (=female)	0.876	***	0.834-0.920				0.880	***	0.838-0.924	0.884	***	0.842-0.929	0.939	***	0.896-0.984	0.961	***	0.915-1.009	0.958	***	0.910-1.008	
Age of cigarette onset	0.982	***	0.976-0.989					***	0.958-0.973	0.966	***	0.958-0.973	0.984	***	0.976-0.992	0.983	***	0.976-0.991	0.981	***	0.974-0.989	
Race/ethnicity* Age of cigarette onset								1.104	***	1.085-1.124	1.104	***	1.085-1.124	1.082	***	1.065-1.099	1.082	***	1.063-1.102	1.084	***	1.065-1.104
Education (vs. less than high school)																						
high school grad	0.481	***	0.443-0.522					***	0.452-0.539	0.494	***	0.452-0.539	0.524	***	0.482-0.570	0.524	***	0.482-0.570	0.530	***	0.487-0.578	
some college	0.304	***	0.281-0.329					***	0.277-0.329	0.302	***	0.277-0.329	0.326	***	0.299-0.355	0.326	***	0.299-0.355	0.323	***	0.294-0.354	
college graduate	0.117	***	0.106-0.129					***	0.109-0.135	0.121	***	0.109-0.135	0.134	***	0.120-0.149	0.134	***	0.120-0.149	0.136	***	0.122-0.153	
age 12-17	0.274	***	0.250-0.301					***	0.240-0.294	0.266	***	0.240-0.294	0.284	***	0.257-0.313	0.284	***	0.257-0.313	0.334	***	0.304-0.368	
Work status (vs. working/has job) ^a																						
keeping house full time	0.932		0.842-1.032							0.765	***	0.689-0.849	0.921			0.765	***	0.689-0.849	0.921		0.827-1.026	
in school/training	1.062		0.978-1.153							0.915		0.831-1.007	0.869	**		0.915		0.831-1.007	0.869	**	0.790-0.957	
no job/retired/disabled	2.319	***	2.144-2.508							1.709	***	1.568-1.863	1.520	***		1.709	***	1.568-1.863	1.520	***	1.392-1.661	
age ≤ 14	0.550	***	0.479-0.631							0.649	***	0.554-0.761	1.545	***		0.649	***	0.554-0.761	1.545	***	1.283-1.861	
Marital status (vs. married) ^b																						
divorced/separated/widowed	2.910	***	2.664-3.178							2.514	***		2.289-2.762			2.514	***		2.289-2.762	2.514	***	2.289-2.762
never married	2.494	***	2.361-2.635							2.186	***		2.021-2.364			2.186	***		2.021-2.364	2.186	***	2.021-2.364

	Univariates		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	OR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
age ≤ 14	0.836	**												
Estimated Crossover Age (years)		0.730-0.957	28.77		28.78		29.58		36.52		37.37		43.08	
χ^2 (df)			1298.54 (4)		1351.09 (5)		1646.41 (7)		6573.00 (11)		6997.15 (16)		8492.48 (18)	

^aCategory for missing cases not reported

^bCategory for age ≤14 omitted in multivariate logistic regressions

* p<05

** p<01

*** p<.001

Table 3

Last month smoking among lifetime smokers at four different ages in 35 grouped birth cohorts from 1985 to 2008 among non-Hispanic whites and African-Americans (AA)

Grouped Birth Cohorts	Age 12-17			Age 18-25			Age 26-34			Age 35+		
	Survey Year	White %	AA %	Survey Year	White %	AA %	Survey Year	White %	AA %	Survey Year	White %	AA %
54-59							1985	47.7	59.5	1994	33.2	44.6
57-62							1988	45.2	46.2	1997	35.2	46.8
59-64							1990	46.1	59.0	1999	30.8	38.8
60-65							1991	42.5	49.9	2000	30.5	42.3
61-66							1992	44.7	51.3	2001	30.0	42.8
62-67				1985	48.1	52.9	1993	39.6	45.7	2002	29.6	43.3
63-68							1994	42.0	47.8	2003	28.7	43.7
64-69							1995	46.2	50.6	2004	29.6	37.6
65-70				1988	46.8	47.3	1996	47.4	50.9	2005	29.5	43.0
66-71							1997	46.2	45.1	2006	28.9	42.5
67-72				1990	46.4	35.0	1998	40.9	49.6	2007	29.0	42.1
68-73	1985	34.9	27.3	1991	46.7	38.4	1999	44.9	41.0	2008	28.3	41.2
69-74				1992	48.0	38.8	2000	43.2	42.7			
70-75				1993	44.9	35.0	2001	43.8	45.2			
71-76	1988	29.8	18.6	1994	51.2	49.3	2002	45.1	60.5			
72-77				1995	52.3	47.1	2003	47.7	45.3			
73-78	1990	29.8	17.1	1996	57.5	51.9	2004	46.9	48.8			
74-79	1991	30.5	17.2	1997	61.5	55.3	2005	49.2	43.6			
75-80	1992	30.5	14.7	1998	62.6	56.7	2006	49.5	48.8			
76-81	1993	29.1	18.9	1999	60.2	47.4	2007	47.4	48.2			
77-82	1994	52.4	45.8	2000	59.3	50.9	2008	49.4	60.5			
78-83	1995	53.1	47.8	2001	59.7	47.3						
79-84	1996	51.7	46.7	2002	61.0	48.9						
80-85	1997	51.8	52.8	2003	60.2	51.4						
81-86	1998	51.6	52.5	2004	61.0	53.5						
82-87	1999	42.3	30.4	2005	61.1	53.4						

Grouped Birth Cohorts	Age 12-17			Age 18-25			Age 26-34			Age 35+		
	Survey Year	White %	AA %	Survey Year	White %	AA %	Survey Year	White %	AA %	Survey Year	White %	AA %
83-88	2000	42.0	25.7	2006	60.9	54.2						
84-89	2001	41.7	26.7	2007	58.5	51.9						
85-90	2002	43.5	24.2	2008	57.3	55.6						
86-91	2003	44.1	30.1									
87-92	2004	45.1	27.1									
88-93	2005	44.0	32.1									
89-94	2006	44.1	29.9									
90-95	2007	46.2	35.9									
91-96	2008	42.2	27.8									

Shaded Age related smoking rates for specific grouped birth cohorts are presented horizontally. Smoking rates are higher among African-Americans than whites within the shaded age categories. Boxed panel highlights the cohorts with data at ages 26-34 and 35+.

Source: For 1985: calculated from NHSDA Reports Main Findings Tables 62, 64, and 66 (SAMHSA 1988).

For years 1988-1998: calculated from NHSDA Main Findings, Tables 8.1, 8.3, 8.5 (SAMHSA 1990-2000). For years 1999-2008: calculated from public use data (SAMHSA 2002-2006; 2007; 2009a;b).