Long-term Effects of Adolescent Smoking on Depression and Socioeconomic Status in Adulthood in an Urban African American Cohort

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ABSTRACT *Despite known adverse causal effects of cigarette smoking on mental health, findings for the effects of adolescent cigarette smoking on later depression and socioeconomic status remain inconclusive. Previous studies have had shorter follow-up periods and did not have a representative portion of the African American population. Using an analytical method that matches adolescent smokers with nonsmokers on childhood and background variables, this study aims to provide evidence on the effects of adolescent regular smoking on adult depression and socioeconomic status. Our longitudinal study is from the Woodlawn Study that followed 1,242 African Americans in Chicago from 1966–1967 (at age 6–7) through 2002–2003 (at age 42–43). We used a propensity score matching method to find a regular and a non-regular adolescent smoking group with similar childhood socioeconomic and family background and first grade academic and behavioral performance. We compared the matched samples to assess the longitudinal effects of adolescent smoking on adult outcomes. Comparing the matched 199 adolescent regular smokers and 199 non-regular smokers, we found statistical support for the effects of adolescent cigarette smoking on later educational attainment (OR, 2.13; 95 % CI, 1.34, 3.39) and long-term unemployment (OR, 1.74; 95 % CI, 1.11, 2.75), but did not find support for the effects on adulthood major depressive disorders. With a community population of urban African Americans followed for 40 years, our study contributes to the understanding of the relationships between adolescent smoking and later educational attainment and employment.*

KEYWORDS *Cigarette smoking, Adolescent health, African American, Longitudinal data, Propensity score matching, Depression, Socioeconomic status*

INTRODUCTION

African Americans are underrepresented in cigarette smoking research; however, compared to White Americans, they have higher age-adjusted death rates from smoking-related causes.^{1,2} Using a life course perspective, adult diseases could originate by adverse exposure during developmental phases in one's early lifetime.³ Exposure to high levels of nicotine during adolescence may affect later adulthood health by causing damage in sensitive developmental phases or by having a cumulative negative effect over time. A high prevalence of smoking

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behaviors was observed among urban, low-income African American adolescents in the 1970s and 2000s⁴⁻⁶ compared to the nationwide prevalence.⁷⁻⁹ The alarmingly high prevalence of cigarette smoking among urban African Adolescents shows that it is urgent to examine the longitudinal effect of smoking behavior in the population.

Research has found cigarette smoking to be associated with several mental illnesses. The odds for current and lifetime cigarette smoking for people with mental illness are 2.7 times more than for those without mental illness.¹⁰ Much evidence has shown that cigarette smoking and depression are highly co-occurring.¹¹⁻¹³ The high co-occurrence of cigarette smoking behavior and mental illness highlights the importance of examining the etiology and causal relationship of this co-morbidity. Researchers have hypothesized two mechanisms to explain the relationship between early smoking and later depressive symptoms. Biological support for this hypothesis is that nicotine alters neurochemicals in the regulatory systems, such as dopamine, norepinephrine, and acetylcholine. This alteration of neurochemicals may in turn affect mood regulation and may be an etiology for major depression.¹⁴⁻¹⁷ Another potential mechanism that may explain the causal effect of cigarette smoking on depression is via psychosocial factors such as rebelliousness. Albers and Biener tested rebelliousness in the pathway and found rebelliousness—measured by several domains related to adolescent problem behaviors—accounted for the association between smoking and depressive symptoms. They found that rebelliousness explained about 15 % of the association between adolescent smoking and depressive symptoms 4 years later.¹⁸ Both biological and psychosocial theories provided support for further statistical analysis of the causal effect of cigarette smoking on depression.

A recent literature review on the consequences of adolescent tobacco use searched articles from 1980–2005 and included large, longitudinal studies with baseline age under 18 years and follow-up at age 18 years or older.¹⁹ Researchers found that most of the studies found positive associations between smoking and depression in adjusted or unadjusted analysis,^{13,14,20-25} while there was also some evidence for not finding cumulative frequency of early tobacco smoking related to later mental illness after adjusting for confounding factors or inconclusive results.^{25,26} The evidence for whether cigarette smoking is a precursor of later depression as detected using data from longitudinal studies remains inconclusive.^{12,27} For example, using a predominantly White sample from upstate New York followed up from 14, 16, 22 to 27 years of age, Brook et al. found—after controlling for sociodemographic characteristics, childhood aggression, prior mental illness, and substance use disorders—that the cumulative frequency of tobacco use during childhood, adolescence, and young adulthood (age 22) was not associated with the risk for episodes of major depressive disorder at age 27. When broken down by each time frame, however, they found that tobacco use prior to the early 20s (adolescence and earlier) predicted major depression in the late 20s, while tobacco use in the early 20s did not predict major depression in the late 20s.²⁵ They also found that tobacco use in late adolescence predicted major depression in the early 20s.²¹ They concluded that these findings may suggest that there is a critical period for the adverse influence of tobacco use on later major depressive disorders. A more recent study using a non-US sample found evidence supporting earlier smoking and later depression among a birth cohort followed from age 17 to 25.²⁸ The other non-US study found that the association between earlier smoking and later depression may differ by gender and

dimensions of depressive symptoms.²⁹ The inconclusiveness of the pathway from cigarette smoking to later depression requires more evidence with different study populations, study design, and research methods.

The independent association between cigarette smoking and socioeconomic status is well documented in the literature.^{30–34} Yet, there is a dearth of studies that examined within-group differences in a high poverty rate population. In this study, we examine the association between adolescent cigarette smoking and later socioeconomic status in a sample of urban African Americans which has a higher poverty level compared to the average people in the USA and to average African Americans.^{35–37}

Our study aims to examine the effect of regular smoking during adolescence on adulthood depression and socioeconomic status in an urban African American population. This study adds to the literature by providing the uniqueness of a longitudinal dataset that follows an urban cohort from age 6 to 42. This paper addresses the following specific questions. (1) Do individuals who smoked cigarettes regularly during adolescence have increased risk of major depressive disorders in young- and mid-adulthood? (2) Are individuals who smoked cigarettes regularly during adolescence more likely to be in a lower socioeconomic status in young adulthood, as measured in educational attainment, employment status, being below or above the poverty line, and receiving welfare or not?

METHODS

Study Participants

The Woodlawn Study is a prospective, longitudinal study that started in 1966–1967 (T1) and consisted of a cohort of first graders (age 6–7, $n=1,242$) from Woodlawn on the south side of Chicago. This cohort of first graders were then followed for three time points of their life: adolescence (T2, age 15–16) in the years 1975–1976, young-adulthood (T3, age 32–33) in the years 1992–1993, and mid-adulthood (T4, age 42–43) in the years 2002–2003. Woodlawn was the fifth poorest of the 76 Chicago communities in the mid 1960s when the study first started.³⁸ At enrollment, 99 % of the subjects were African American; 51.2 % were females.

Attrition Analysis

Attrition analyses from previous studies using the Woodlawn data found that for adolescents in T2, there were no differences in young adult marital status, employment, depression, or living in a high-poverty tract between adolescents who completed the survey and those who did not complete the T2 survey but later answered the T3 survey.³⁹ Comparing data from adulthood (T3 and T4), people who did not finish high school were less likely to be interviewed in T3 or T4 compared to those with GED or high school diplomas. There were no differences in sex, childhood personality, or mother's educational level between those who were interviewed in at least one of the adulthood surveys and those who were interviewed in both adulthood surveys in T3 and T4.⁴⁰

MEASURES

Dependent Variables

Depression in T3 and T4. The mental disorders assessed that are of interest included anxiety and depression. To measure depression in T3 and T4, a series of questions

were adapted from the Michigan version of the Composite International Diagnostic Interview (CIDI), developed for the National Comorbidity Survey.^{41,42} Lifetime diagnosis of major depressive episodes in adulthood, combining T3 and T4, were generated based on DSM-III-R criteria in T3 and DSM-IV in T4, using the CIDI depression module.

Socioeconomic Status at T3. Socioeconomic status (SES) at T3 was measured by the following variables: (1) Education is determined by a series of questions about the last time an individual had formal schooling or any degrees obtained. Answers were categorized into low (1, no diploma or with a GED) and high (0, high school graduate or higher). (2) Poverty level was assessed based on the federal government's definition of 1994 accounting for household income and size. Answers were categorized as under the poverty level or not (yes=1, no=0). (3) Whether they received welfare at the time of assessment (yes=1, no=0). (4) Current employment status was assessed by their working status in the previous week (employed or not; yes=0, no=1). (5) Unemployment status was assessed by whether they had ever been unemployed for 3 months or more when they wanted to be employed (yes=1, no=0). We used different indicators of socioeconomic status to capture different dimensions for socioeconomic status that are not interchangeable.^{43,44}

Independent Variable

Regular Smoking at Adolescence. Adolescents were asked to self-report their current smoking status. They were asked about how often they smoked cigarettes on a scale of *never*, only one to two times ever, *occasionally*, less than one pack a day, or a pack a day or more. Regular smoking (=1) was defined as those who smoked a pack a day or more and less than a pack a day. Non-regular smoking (=0) included those who smoked occasionally, only smoked once or twice ever, or never smoked.

Matching Variables

Gender. Children's gender is a constant variable throughout life course (female=0, male=1).

Mother's Smoking and Alcohol Use Status. Mother's smoking and alcohol use status were self-reported by mothers or mother surrogates at the time of the adolescent interview. They were asked whether they had used cigarettes and alcohol at T2, and if *yes*, how much they had used them in the last 12 months. Answers of smoking and alcohol use, separately, were categorized as *yes* (1=regular users) or *no* (0=not regular users).

Family Socioeconomic Status. (1) Mothers' SES was indicated by self-reports of their educational attainment at T1, the amount of schooling they had completed on a range of 0–18 years. Answers were categorized as *high* (1, finished high school or more) or *low* (0, did not finish high school or lower). (2) Poverty level and whether the family received welfare at T1 were also used to indicate family socioeconomic status. Poverty level and receiving welfare, separately, were dichotomized into *yes* (=1) and *no* (=0).

Childhood Behavioral Characteristics. Teachers were asked to rate each child on five aspects of school adaptation on a scale of 0 (adapting) to 3 (severely maladapting) using the Teacher Observation of Classroom Adaptation (TOCA) scale at T1.³⁸

School Performance. Teachers were asked to report each child's reading and math grades at T1 on a scale of 1 (excellent) to 4 (unsatisfactory).

Mothers' Expectation for Educational Attainment. Mothers were asked at T1 about how far they thought their child would actually go in school on a scale of 1 (some high school or finish high school) to 4 (beyond college).

Residential Mobility. Mothers were asked how many times they had moved after the child was born, up to the time interviewed in T1 (answers ranged from 0–9).

Mother's Mental Health. Mothers' early psychological distress at T1 was measured by the frequency of their self-reported anxious mood (feeling nervous, tense, or edgy) and depressed mood (feeling sad or blue), separately, on a scale of 1 (hardly ever) to 4 (very often).

Children's Psychological Symptoms. Using 33 items from the Mother's Symptom Inventory, adapted from Connors' instrument,³⁵ mothers were asked to rate how true were the statements as to whether the child had the following problems on a scale of 0 (not at all) to 3 (very much) at T1: symptoms such as restless or awakens at night, afraid of new situations, looks sad, stutters, etc. (Cronbach's $\alpha=0.83$). After summing up the total scores of the 33 items, the score was categorized into three groups: low (0–6 points), medium (7–12 points), and high (13 or more points).

ANALYSIS

Propensity Score Matching

To evaluate the long-term effect of adolescent cigarette smoking, we used propensity score methods instead of the traditional regression methods to estimate causal effects by creating treatment and control groups that have similar distributions of observed covariates in observational studies.^{45,46} Propensity score matching avoids heavy dependence on the model assumption compared to standard regression and provides stronger evidence to minimize selection bias.⁴⁷ Propensity score methods use only observed covariates, but not the outcomes, to reach a good balance of covariates between treatment and control groups.⁴⁸ Applications of propensity score methods in examining longitudinal effects in observational research include, but are not limited to, studies that looked at developmental trajectory and substance use.^{39,49–52}

The propensity score matching method was used to account for early-life or childhood covariates in relation to adolescent smoking and to obtain a matched sample. For propensity score matching, all analyses were conducted with STATA statistical software.⁵³ The propensity score was first estimated with logit function, using the *psmatch2* program in STATA. Then various 1-to-1 nearest-neighbor matching methods were tested to reach the best covariate balance between the matched treatment (regular smoking) and control (non-regular smoking) groups.

Good balance was determined by having improved balance, with standardized bias lower than 0.25 after matching,⁵⁴ having similar covariate distributions in the matched treatment and control groups, and graphs showing the distribution of propensity scores by the matched treatment and control group. Once the matching was completed, a matched sample was selected and used for outcome analysis.

Outcome Analysis

After the matched sample was selected, we used this subsample that has a group of regular smokers and non-regular smokers with similar background characteristics to estimate the effect of adolescent regular smoking on adulthood depression and socioeconomic status by logistic regression models.

Missing Data

All the missing values in each covariate used for matching were less than 7 %. We used mean and mode replacement for matching variables that had less than 5 % missing values for continuous and categorical variables, respectively. For matching variables that had missing values more than 5 %, we generated a missing category and used it for matching, which was a method used in other studies.⁵⁵ Out of 703 study participants, 15 % did not complete the survey in young adulthood and 27 % did not complete the mid-adulthood survey. For outcome variables, we did multiple imputation, using *ICE* program in STATA.⁵⁶ We imputed five datasets using variables in four phases in the dataset and used the multiply imputed dataset for outcome analysis with the *MIM* program in STATA.⁵⁷

RESULTS

Sample Characteristics

Among the 703 adolescents in the late 1970s, 29 % reported smoking less than one pack a day or more than one pack a day—as categorized as regular smokers in this study—versus 71 % of non-regular smokers that reported never smoked, smoked one to two times ever, or only smoked occasionally. In Table 1, of the 703 participants, about 38 % were below the poverty line, 35 % did not have a current job during the interview time in young adulthood, 62 % had experienced long-term unemployment, 30 % were receiving welfare, and 24 % had not finished high school in 1992–1994. About 16 % of participants were categorized as having a major depressive disorder in young and mid-adulthood combined. Without any adjustment for confounders and before matching, regular smoking in adolescence is associated with a few adult social and behavioral outcomes (see Table 1).

Propensity Score Matching

Before propensity score matching, bivariate analysis for matching variables in childhood found that adolescents who were regular smokers were more likely to be male, had higher teacher assessments of aggressive and restless behaviors, had a mother who smokes, and had higher residential mobility in childhood (see Table 2). A matched sample was selected using 1-to-1 nearest-neighbor matching without replacement within a caliper of width of a quarter of the standard deviation of propensity score. The matched sample was composed of 199 regular smokers and 199 non-regular smokers in adolescence. All the absolute standardized bias of the

TABLE 1 Descriptive and bivariate analysis for adult SES, social integration, and mental health outcomes, before matching (N=703)

	Complete (N=703)	Regular smokers (N=206, 29 %)	Non-regular smokers (N=497, 71 %)	χ^2	p value
Socioeconomic status at T3					
Poverty index					
Yes	210 (37.91 %)	77 (48.73 %)	133 (33.59 %)	11.01	0.001
No	344 (62.09 %)	81 (51.27 %)	263 (66.41 %)		
Current work status					
No	209 (35.07 %)	74 (42.53 %)	135 (31.99 %)	6.01	0.014
Yes	387 (64.93 %)	100 (57.47 %)	287 (68.01 %)		
Unemployed for 3 months					
Yes	350 (62.06 %)	118 (73.75 %)	232 (57.43 %)	12.97	0.000
No	214 (37.94 %)	42 (26.25 %)	172 (42.57 %)		
Received welfare					
Yes	179 (30.34 %)	63 (37.06 %)	116 (27.62 %)	5.1	0.024
No	411 (69.66 %)	107 (62.94 %)	304 (72.38 %)		
Education					
Low	154 (24.25 %)	72 (38.92 %)	82 (18.22 %)	30.6	0.000
High	481 (75.75 %)	113 (61.08 %)	368 (81.78 %)		
Depression at T3 and T4					
T3 and T4 major depressive disorder					
Yes	98 (15.63 %)	31 (16.85 %)	67 (15.12 %)	0.29	0.588
No	529 (84.37 %)	153 (83.15 %)	376 (84.88 %)		

Continuous variable: show mean (SD)

matching variables was below 25 % after matching; none of the matching variables were significantly associated with regular smoking in adolescence (see Table 2).

Outcome Analysis

The results of regression analysis for the effect of adolescent regular smoking on SES and social integration outcomes in young adulthood, using the propensity score matched sample and the multiply imputed data, are shown in Table 3. Compared to non-regular smokers, adolescent regular smokers were significantly more likely to report being unemployed for 3 months and to have lower educational attainment. The odds of not finishing high school or having a GED for adolescent regular smokers was 2.13 times more than the odds of finishing high school or higher education, compared to non-regular smokers (95 % CI, 1.34–3.39). The odds of being unemployed for 3 months while wanting to be employed was 1.74 higher for adolescent regular smokers than for non-regular smokers (95%CI, 1.11–2.75). No significant associations were found in the multivariable analysis for major depressive disorder in adulthood, poverty level, current employment status, or receiving welfare or not between regular smokers and non-smokers using the matched sample (Table 3).

Traditional Adjustment

We compared the results using propensity score matching to the more traditional regression model for the data, multiple logistic regression with full sample (N=703), and found that results are similar in all of the socioeconomic status variables and

TABLE 2 Distribution of matching covariates for regular and non-regular adolescent smokers before matching and standardized bias before and after matching (N=703)

Matching variables	Regular smoking (N=206)	Non-regular smoking (N=497)	p value	Standardized bias before matching	Standardized bias after matching
Gender			0.03	0.19	-0.15
Female	92 (45 %)	268 (54 %)			
Male	114 (55 %)	229 (46 %)			
Mother's education			0.32		
<high school ^a	119 (58 %)	272 (55 %)			
High school or higher	72 (35 %)	199 (40 %)		-0.11	0.12
Missing	15 (7 %)	26 (5 %)		0.09	-0.12
Poverty index at T1			0.179	0.15	-0.12
Poverty	113 (55 %)	235 (48 %)			
No	83 (40 %)	237 (48 %)			
Missing ^b	10 (5 %)	25 (5 %)			
Welfare index at T1			0.219	0.07	-0.15
On Welfare	71 (34 %)	155 (31 %)			
No	130 (63 %)	337 (68 %)			
Missing ^b	5 (2 %)	5 (1 %)			
Child's behavior: mean (SD)					
Immaturity [0-3]	0.65 (0.98)	0.57 (0.93)	0.36	0.08	-0.11
Shy [0-3]	0.47 (0.84)	0.45 (0.80)	0.76	0.03	0.08
Aggressiveness [0-3]	0.7 (1.01)	0.44 (0.85)	<0.01	0.28	-0.24
Underachievement [0-3]	0.68 (0.94)	0.63 (0.95)	0.49	0.06	-0.08
Restlessness [0-3]	0.73 (1.04)	0.50 (0.93)	<0.01	0.24	-0.18
Missing ^{b,c}	0 (0 %)	4 (1 %)			
Child's personality symptoms			0.69		
Low ^a	82 (40 %)	175 (35 %)			
Medium	67 (33 %)	175 (35 %)		-0.06	0.02
High	56 (27 %)	143 (29 %)		-0.04	0.16
Missing ^b	1 (5 %)	4 (1 %)			
Reading ability			0.095		
Low (fair/unsatisfactory) ^a	78 (38 %)	232 (47 %)			
High (good/excellent)	114 (55 %)	233 (47 %)		0.17	-0.09
Missing	14 (7 %)	32 (6 %)		0.01	-0.01
Mother's smoking status			<0.01	0.26	-0.13
Yes	99 (48 %)	176 (35 %)			
No	102 (50 %)	300 (60 %)			
Missing ^b	5 (2 %)	21 (4 %)			
Mother uses alcohol regularly			0.14	0.16	-0.07
Yes	27 (13 %)	41 (8 %)			
No	173 (84 %)	441 (89 %)			
Missing ^b	6 (3 %)	15 (3 %)			
Mother's anxiety (nervous/tense/edgy)			0.23		
Hardly ever ^a	25 (12 %)	78 (16 %)			
Occasionally	94 (46 %)	233 (47 %)		-0.03	0.13
Fairly often	25 (12 %)	74 (15 %)		-0.08	0.13
Very often	47 (23 %)	88 (18 %)		0.13	-0.2
Missing	15 (7 %)	24 (5 %)		0.1	-0.12

TABLE 2 (continued)

Matching variables	Regular smoking (N=206)	Non-regular smoking (N=497)	<i>p</i> value	Standardized bias before matching	Standardized bias after matching
Mother's depression (sad/blue)			0.22		
Hardly ever ^a	72 (35 %)	196 (39 %)			
Occasionally	94 (46 %)	195 (39 %)		0.13	−0.02
Fairly often	12 (6 %)	43 (9 %)		−0.11	0.04
Very often	13 (6 %)	39 (8 %)		−0.06	0.13
Missing	15 (7 %)	24 (5 %)		0.1	−0.12
Mother's expectation of education achievement			0.91		
Up to finishing high school ^a	31 (15 %)	63 (13 %)			
Some college	15 (7 %)	42 (8 %)		−0.04	0.01
Finish college	126 (61 %)	313 (63 %)		−0.03	0.05
Beyond college	32 (16 %)	75 (15 %)		0.01	0
Missing ^b	2 (1 %)	4 (1 %)			
Residential mobility (times moved): mean (SD) [0–9]	2.38 (1.80)	2.09 (1.68)	0.04	0.17	0.02
Missing	0 (0 %)	2 (.4 %)			

^aFirst category was used as reference when matching as categorical variable, hence no standardized bias was calculated

^bFor missing values less than 5 %, simple mean/mode replacement was used for missing values, hence no missing category was used for matching and no standardized bias was calculated

^cApplied to all TOCA items

major depressive disorders in adulthood, except for poverty. The odds ratios were similar and most determinations of the statistical significance were the same. The only difference was that poverty at T3 was significantly associated with adolescent smoking, using traditional logistic regression (OR, 1.51; 95%CI, 1.03–2.22), but not significant with propensity score matching adjustment. The propensity score

TABLE 3 Association between adolescent regular smoking and young adult socioeconomic status, and major depressive disorder in young and mid-adulthood, using the propensity score matched sample of 398 individuals from the Woodlawn study, 1966–2002

Propensity score matched sample	OR	95 % confidence interval	<i>p</i> value
Socioeconomic status at T3			
Poverty index (yes vs. no)	1.26	0.84, 1.90	0.26
Current work status (no vs. yes)	1.22	0.80, 1.86	0.36
Unemployed for 3 months (yes vs. no)	1.74	1.11, 2.75	0.02
Received welfare (yes vs. no)	1.22	0.77, 1.94	0.39
Education (low vs. high)	2.13	1.34, 3.39	0.00
Depression at T3 and T4			
Major depressive disorder (yes vs. no)	1.17	0.67, 2.04	0.59

matching result was preferred because it ensured that the two comparison groups had similar multivariate distributions.

DISCUSSION

We evaluated the effect of adolescent smoking on adulthood outcomes using a sample of inner-city African Americans. This study is one of the few studies that examined a large sample of inner-city African Americans. Our analysis found support for the effect of cigarette smoking on adulthood educational attainment and long-term unemployment, but did not find statistical support for major depressive disorders. We suggest that the effects of cigarette smoking should be further examined within various social and ethnicity contexts—such as biological, pharmacological, and social-behavioral mechanisms—to fully understand how cigarette smoking in critical periods of human development (e.g., adolescence) affects adulthood outcomes via different pathways.

Consistent with the literature of socioeconomic status and smoking, we found robust evidence for an association between adolescent smoking and later educational attainment in this urban, African American population.^{30,58,59} Building on the literature, our study further demonstrates that—even after matching for mothers' education, children's school performance, mothers' aspirations for children's educational attainment, and other factors—adolescent smoking is a significant, alarming signal for individuals to have lower educational attainment in adulthood. Regular smoking patterns were established at ages 15–16, a critical time point to determine whether they could finish high school. These regular smoking adolescents may be more likely to have other deviant behaviors, such as dropping out of school, since they were already smoking against school regulations.⁶⁰ It could also be that their smoking behavior was associated with being with deviant peer groups, and in turn associated with dropping out of high school. Cigarette smoking and dropping out of school were both found to have strong peer-group effect in a sample of tenth graders, meaning that students were more likely to smoke cigarettes or drop out of school if they were with a peer group that had a higher prevalence of these behaviors.⁶¹

We also found that adolescent cigarette smoking was related to having experienced long-term unemployment in young adulthood, even though we did not find statistically significant association for current job status. This is supported by economic research findings that smokers are associated with higher likelihood to have riskier jobs and have higher job injuries than non-smokers.⁶² People with riskier jobs may be less likely to maintain long-term employment, which might be the reason why we observed the effect of smoking on long-term unemployment, but not on current job status.

We found no significant differences in major depressive disorders in adulthood between adolescents who smoked cigarettes regularly and those who did not in the sample of African Americans in the Woodlawn community. In a recent review of consequences of adolescent tobacco use that searched articles from 1980–2005 and included large, longitudinal studies with baseline age under 18 years and follow-up age 18 years or older, researchers found that most of the studies found positive associations between smoking and depression in adjusted or unadjusted analysis.¹⁹ There is also some evidence, however, for not finding cumulative frequency of early tobacco smoking related to later mental illness after adjusting for confounding factors or for inconclusive results.^{25,26}

There are several major differences between our study and the previous studies. First, we have 25 years of follow-up time, which is longer than most of the studies that only followed up for 10 years after the baseline age in adolescence.^{20,23,24,63}

Second, we used propensity score and matched a group of smokers with non-smokers that had similar childhood characteristics and background factors, including mothers' socioeconomic status and substance use behaviors, mothers' mental health, childhood personality, and school performance to help us examine the long-term effects of smoking. We have a more thorough list of background factors and a different statistical method to obtain the effects of adolescent smoking on adult depression. Third, there are various definitions and measurements for cigarette smoking and depression in the literature, which may contribute as one of the reasons for inconclusive findings regarding early smoking and later mental illness. Lastly, it may also be that the potentially drug-induced negative effect of nicotine on mood regulation was mediated or mitigated by unhealthy behaviors, such as smoking itself or using other substances and overeating.¹⁴⁻¹⁷ Other research has hypothesized that engaging in unhealthy behaviors, such as smoking and overeating, may be one of the coping methods for African Americans in response to day-to-day stressful conditions, such as poverty or crime.⁶⁴ Yet, we need future research to examine the role of stress and unhealthy behaviors as coping mechanisms in the pathways of smoking and depression in this population.

Our study has a few limitations. Even though propensity score matching helped reduce selection bias, our observational study still cannot adjust for unobserved confounders, such as genetic origins of mental illness and addiction. Our study population is inner-city African Americans; hence, the results may not be applicable to other non-urban populations. Our measurement of smoking behavior and depression were based on self-reported data; hence, the actual prevalence of clinical major depressive disorders may not be accurate and we do not know whether there would be a differential self-report bias of mental illness between smokers and non-smokers. Also, this study would benefit from including various measures for smoking behavior and dimensions of depressive symptoms.²⁹ Our study did not test for other potential causal pathways, such as mental illness-caused initiation and maintenance of smoking, or whether there is a third factor that causes both mental illness and cigarette smoking, such as genetic or environmental factors. To fully understand the causal picture of smoking and mental illness, we need more information as to when and why the individuals first initiated and maintained cigarette smoking.

This study highlights the importance of addressing the issue of tobacco access among urban African Americans. A recent nationwide study found that African Americans were only half likely to quit smoking or use nicotine replacement therapy compared to White Americans.⁶⁵ There are several environmental factors that may foster the increase in recent years of current smoking prevalence among urban African Americans: targeted advertisements from tobacco companies in poor neighborhoods, cigarettes being sold in urban neighborhood stores more often than fresh food, and easy access to single cigarettes on the street that averts challenging tax policies.^{4,66,67} A recent study also shows a strong association between high exposure to tobacco retail outlets and smoking initiation among adolescents in major urban cities.⁶⁸ Our study result for the negative impact of adolescent smoking on adulthood educational attainment and unemployment, combined with access to cigarettes in urban neighborhoods, highlights the importance of interventions targeting young urban African American children and adolescents.

Our study contributes to public health by providing another evidence to understanding the causal relationships between adolescent smoking and adult mental health, and social and behavioral outcomes, which still remain inconclusive

in the cigarette smoking literature. The strength of our study is that our study population is a large sample of inner-city African Americans that was followed for 40 years. This allowed us to use temporal order to control for many potentially confounding variables in the early lifetime. More epidemiological and basic science research is needed to support the plausible biological mechanisms underlying the hypothesis that cigarette smoking leads to depression by altering neurochemicals. Other causal links need to be examined to understand the high comorbidity of mental illness and cigarette smoking. We also argued that the effect of adolescent smoking on social and behavioral factors and mental illness should be examined within ethnical and cultural contexts. There is a need for more research with various research designs and analytical methods to examine the causal effects of cigarette smoking on adult outcomes in consideration of socio-environmental factors that may mask the pharmacological effects of cigarette smoking and impact people's quitting and maintenance behaviors.

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