Published in final edited form as:

J Adolesc Health. 2018 March ; 62(3): 327–333. doi:10.1016/j.jadohealth.2017.09.019.

Ethnic Differences in Cigarette Use Trajectories and Health, Psychosocial, and Academic Outcomes

Michael S. Dunbar, PhD^a, Joan S. Tucker, PhD^b, Brett A. Ewing, MS^b, Layla Parast, PhD^b, Eric R. Pedersen, PhD^b, Anthony Rodriguez, PhD^b, Elizabeth J. D'Amico, PhD^b

^aRAND Corporation, 4750 Fifth Avenue, Suite 600, Pittsburgh, PA 15213, USA

^bRAND Corporation, 1776 Main Street, Santa Monica, CA 90401, USA

Abstract

Purpose: Cigarette smoking among youth is associated with poorer health and psychosocial outcomes. However, few studies address how smoking may differentially relate to the emergence of disparities in functioning across races/ethnicities over adolescence.

Methods: Youth ($n=2,509$) were surveyed eight times from ages 11–18. We measured cigarette use, academic and social functioning, mental and physical health, and delinquency. Sequelae of change models controlled for sociodemographic factors, and tested whether intercept and slope for smoking trajectories were associated with outcomes at the end of high school, and examined racial/ethnic differences in outcomes assuming similar smoking trajectories across groups.

Results: Youth were 45% Hispanic, 20% Asian, 20% White, 10% Multi-ethnic, 2% Black, and 1% other ethnicities. Higher average probability of smoking and steeper slopes of smoking trajectories were associated with poorer outcomes in multiple domains. Controlling for smoking trajectories, we observed the following disparities (vs. White youth; all p 's < .05): Black, Hispanic and Multi-ethnic youth reported lower academic performance; Asian, Black and Multi-ethnic youth reported higher academic unpreparedness; Asian and Multi-ethnic youth reported poorer mental health; Asian, Hispanic, and Multi-ethnic youth reported poorer physical health; and Asian youth reported higher delinquency and poorer social functioning.

Conclusions: Statistically adjusting for similar smoking trajectories, racial/ethnic minority youth demonstrated poorer outcomes in multiple domains compared to White peers. Smoking may be a particularly robust marker for risk of negative outcomes in racial/ethnic minority youth. Screening for cigarette use and intervening on smoking and associated risk behaviors among minority youth may help reduce disparities in functioning.

Correspondence concerning this article should be addressed to: Michael Dunbar, PhD, RAND Corporation, 4750 Fifth Avenue, Suite 600, Pittsburgh, PA 15213, USA, Phone: 412-683-2300 x4219, Fax: 412-683-2800, mdunbar@rand.org.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Keywords

Cigarette smoking; Smoking trajectories; Youth smoking; Tobacco-related disparities; Racial and ethnic disparities

---

Introduction

Smoking is associated with negative outcomes across multiple functional domains, and disparities may emerge early in a smoker's career. Adolescence is a critical period for initiation of risk behaviors like smoking,^{1,2} and can set the stage for health trajectories over the life span. Youth who initiate smoking and continue to smoke demonstrate poorer academic and occupational outcomes, social difficulties, behavioral problems, and more physical and mental health problems in young adulthood relative to individuals who abstain entirely or desist after a period of experimentation.¹⁻⁵ These relationships likely arise through multiple pathways. For example, in addition to the direct deleterious effects of smoking (e.g., on cardiovascular functioning),⁶ smoking during adolescence is associated with other risk behaviors (e.g., other drug use; delinquent behavior)¹⁻⁵ that are in turn associated with poorer health, psychosocial, and academic outcomes.^{3, 7}

Certain groups experience worse smoking-related outcomes, and tobacco-related health and other disparities across racial/ethnic groups are well-documented among adults.^{8,9} These disparities cannot be explained solely by disparate rates of cigarette exposure or consumption over time, and may arise through complex interactions between smoking and other risk factors (e.g., genetic risk factors, dietary and other health behaviors, environmental stressors, etc.).¹⁰ This suggests that similar patterns of smoking may have disproportionately negative effects for some racial/ethnic groups. Yet, little is known about when during one's lifetime such tobacco-related disparities manifest, and what types of racial/ethnic disparities may exist among youth who smoke. Investigating whether/how smoking during adolescence may disproportionately affect youth of different racial/ethnic groups has critical implications for understanding the role of cigarette smoking in the emergence of health, academic, psychosocial, and other disparities.

Although studies indicate that racial/ethnic minority youth are *less likely* to smoke cigarettes than their White peers,¹¹⁻¹⁴ and White adolescents tend to initiate regular smoking at younger ages compared to Black,¹⁵⁻¹⁷ Asian,¹⁶⁻¹⁸ and Hispanic youth,^{14,18} it is unclear whether and how smoking differentially relates to outcomes among youth of different racial/ethnic groups. Few longitudinal studies examine cigarette smoking trajectories among ethnically diverse samples of youth, and most studies examine racial/ethnic differences across only two or three ethnic groups.^{11,16-18} Furthermore, few studies examine the association between smoking trajectories and functioning in multiple health, psychosocial and academic domains.^{2,3} Longitudinal research with diverse groups is necessary to understand how smoking during adolescence may differentially affect ethnic groups and contribute to disparities later in life. Given the multiple pathways through which tobacco-related disparities may develop,^{10,19} examining different outcomes is critical to understanding how smoking may differentially relate to disparities in functioning. This is

important because even though youth cigarette use is on the decline, 28% of youth in 2016 reported having used cigarettes by the time they were in 12th grade.²⁰ To our knowledge, no studies have examined the association between adolescent smoking trajectories and disparities across multiple outcomes at the end of high school for youth of different racial/ethnic groups. Recent work examining alcohol and marijuana (AM) use trajectories for adolescents suggests that after adjusting for similar trajectories AM use, relative to White youth, Hispanic and multi-ethnic adolescents reported poorer academic performance; Asian, Black, and Hispanic youth reported higher academic unpreparedness; and Asian youth and multi-ethnic youth reported poorer physical health.⁷ This suggests that AM use during adolescence may disproportionately affect functioning in adolescence for some racial/ethnic groups. However, it is unknown whether *cigarette use* during adolescence has differential associations with functioning for youth of different ethnicities.

The current study addresses gaps by modeling the association between trajectories of adolescent cigarette use from middle school through high school (ages 11 through 18), and examining how trajectories affect academic, mental and physical health, and social outcomes at the end of high school across different ethnic groups in a diverse sample of adolescents from Southern California. This study uses methods similar to those employed in a recent study,⁷ which examined racial/ethnic differences in trajectories of adolescent AM use in relation to these outcomes. We hypothesize that racial/ethnic minority youth will show disproportionately poorer outcomes at the end of high school compared to their White peers, after controlling for smoking trajectories during adolescence (i.e., assuming similar smoking trajectories over time across groups). Findings will advance the understanding of the role of cigarette smoking in the emergence of disparities across racial/ethnic groups, and yield important insights into intervention targets for clinicians and tobacco control efforts.

Methods

Sample and Procedures

Participants were from two cohorts of students in 6th and 7th grade in 2008, followed through 2016. Adolescents (n=6,509) were initially recruited from 16 middle schools from three districts in the Los Angeles area as part of an alcohol and drug use prevention program, CHOICE.²¹ The three districts were similar in terms of socioeconomic (e.g., the proportion of students receiving free or reduced lunch) and student demographics.²¹ Procedures were approved by the institution's IRB. Procedures are reported in detail in the prevention trial.²¹ Briefly, participants completed waves 1 through 5 (wave 1: Fall 2008; wave 2: Spring 2009; wave 3: Fall 2009; wave 4: Spring 2010; wave 5: Spring 2011) during physical education classes at 16 middle schools. Follow-up rates ranged from 83% to 95%. Adolescents transitioned from middle schools to over 200 high schools following wave 5, and were subsequently re-contacted and re-consented to complete annual web-based surveys. At wave 6 (Spring 2013-Spring 2014), 61% of the sample participated in the follow-up survey. At wave 7 (one year later), we retained 80% of the sample, and at wave 8 (one year later; when most students had completed high school) we retained 90.5% of the sample. Drop out was not associated with demographics or risk behaviors, including alcohol and drug use.⁷

Measures

Cigarette smoking at waves 1–8 was assessed using the *Monitoring the Future*²⁰ item: “During the past month, how many days did you smoke cigarettes?” Responses ranged from 0 to 20–30 days. Due to considerable skew, responses were dichotomized to indicate any (1) vs. no (0) smoking.

Socio-demographics and race/ethnicity at wave 1 included self-reported age, gender, race/ethnicity, and mother’s education (as a proxy for socioeconomic status). Participants were classified into one of six racial/ethnic groups: non-Hispanic White (reference group), non-Hispanic Black, Hispanic, Asian, Multi-ethnic (more than one race/ethnicity), and any other ethnicities.

Academic, health, and social outcomes at wave 8—*Academic orientation* assessed a combination of self-reported grades in past year (1= “mostly F’s” to 8= “mostly A’s”),²² highest level of education students intended to complete (1= “I may not finish high school” to 6= “I plan to go to graduate school or professional school”),²³ and how much students agreed with the statement “Getting good grades is important to you” (1= “strongly disagree” to 5= “strongly agree”). Item responses were standardized (mean=0, SD=1) and summed, with higher scores indicating better outcomes.

Academic unpreparedness was measured using four items, assessing how often the respondent went to class (1) late, (2) without homework done, (3) without paper and pencil, and (4) without books (1= “never” to 4= “often”).²⁴ Items were summed, with higher scores indicating greater academic unpreparedness.

*Physical ailments/symptoms*²⁵ assessed how bothered participants had been the previous 4 weeks by four symptoms: stomach pain, headaches, feeling tired or having low energy and trouble sleeping. Responses were dichotomized as 0= “not at all bothered” and 1= “bothered a little or a lot,” and summed, with higher scores indicating more ailments/symptoms.

Physical health was assessed with a combination of subjective overall health (1= “excellent” to 5= “poor”), ability to physically engage in activities that one enjoys (1= “with no trouble” to 5= “not able to do”), and ability to participate in sports/activities similar to their peers (1= “with no trouble” to 5= “not able to do”).²⁶ Items were reverse scored and summed, and higher scores indicated better physical health.

Mental health was assessed using the Mental Health Inventory (MHI)-5.²⁷ Five items assessed frequency of mood/mental health symptoms in the past 30 days (e.g., “been nervous or anxious”), rated on a 6-point scale (1= “none of the time” to 6= “all of the time”). Items were summed and transformed to a 0 to 100 scale, with higher scores indicating better overall mental health.

Social functioning in the past month was assessed using seven items from the PROMIS Peer Relationships Short Form item bank (e.g., “I was able to count on my friends”)²⁸ rated on a 5-point scale (0= “never” to 4= “always”). Scores were transformed to a t-score, with higher values indicating better social functioning.

Delinquency was assessed via eight items on the frequency with which youth engaged in various problem behaviors in the past year (e.g., skipping school, stealing),²⁹ rated on a 6-point scale (1= “not at all” to 6= “20 or more times”). Scores were summed, with higher values indicating greater delinquency in the past year.

Analysis

We used latent growth modeling (LGM) in a structural equation modeling (SEM) framework, implemented in Mplus v8³⁰ to examine trajectories of cigarette use. This framework allows for change itself to serve as both an outcome *and a predictor*. We used weighted least squares with mean and variance adjusted estimator (WLSMV), which can accommodate missing data and provide unbiased and consistent estimates.³¹ In LGM, the model intercept represents the predicted value of the outcome when the predictor is equal to zero. Because assessment waves were not evenly spaced across years, this was set to 3.25 years after baseline assessment. That is, time was centered at the middle of assessment waves.⁷ Between waves 1 and 8, there were 6.5 total years, which were treated as follows in the growth models: wave 1 = 0 years, wave 2 = 0.5 years, wave 3 = 1 year, wave 4 = 1.5 years, wave 5 = 2.5 years, wave 6 = 4.5 years, wave 7 = 5.5 years, and wave 8 = 6.5 years. Thus, the intercept can be interpreted as the average probability of cigarette use.⁷ The slope represents the change in the probability of use over time.

Next, we examined race/ethnicity (dummy coded, with White as the reference category) as a predictor of the slope and intercept of cigarette use, controlling for age, gender, mother’s education, and intervention group at wave 1. We then tested whether slope and intercept for cigarette use were associated with outcomes at wave 8 across the full sample. Finally, we examined race/ethnic differences in outcomes by estimating a model controlling for slope and intercept of cigarette use predicting outcomes, looking at the direct effect from race/ethnicity to each outcome. We used a sequelae of change model.³² In SEM, this specification allows the random effect of the rate of change of cigarette use to function as both an outcome (as it is conventionally modeled), as well as a *predictor* of subsequent outcomes. All models adjusted for age, gender, mother’s education, and intervention group at wave 1.

Results

Sample

Table 1 shows descriptive information for the sample (n = 2,509). Respondents were 46% male, racially/ethnically diverse, with an average age of 18.33 (SD=0.78), and 75% were in college or trade school at wave 8.

Predictors of intercept and slope of cigarette use

The first model examined race/ethnic differences in the intercept and slope for cigarette use across waves 1–8, adjusting for age, gender, mother’s education, and intervention group at wave 1. The intercept represents average probability of cigarette use and slope represents change in probability of use over time, both modeled as a logistic function due to the binary

distribution of the smoking status variable. Overall model fit was good, $\chi^2(85) = 99.96$, $p = 0.13$, RMSEA = 0.004, CFI = 0.99.

Race/ethnicity predicted average probability of use (intercept) and change in probability of use (slope) over time (see Table 2). Figure 1 shows the percent of past-month smoking across racial/ethnic groups at each assessment point. Compared to White teens, average cigarette use for Asian teens was significantly lower (i.e., approximately 33% less likely to smoke [logistic results exponentiated]). Regarding slopes, Hispanic teens had less steep slopes than White teens, indicating that the rate of change of smoking was less for Hispanic teens. There were no other significant racial/ethnic differences. Older teens showed higher average probability of cigarette use ($B = 0.10$, 95% CI = 0.05, 0.14, $p < 0.001$) and less steep increases in cigarette smoking ($B = -0.05$, 95% CI = -0.07, -0.03, $p < 0.001$) over time. Compared to females, average cigarette use was higher for males ($B = 0.07$, 95% CI = 0.00, 0.14, $p < 0.001$) (i.e., approximately 10% more likely to smoke than females) and was associated with higher rates of change in cigarette smoking over time ($B = 0.03$, 95% CI = 0.00, 0.05, $p < .05$). Mother's education did not significantly predict average cigarette use but did predict rate of change in cigarette use ($B = 0.05$, CI = 0.02, 0.07, $p < .01$) such that having a college educated mother was associated with a slightly increasing rate of change in cigarette smoking.

Effects of cigarette use on wave 8 outcomes (end of high school)

We next examined intercept and slopes of cigarette use from model 1 as predictors of outcomes measured at wave 8, controlling for age, race/ethnicity, mother's education, and intervention group (Table 3). The overall model fit well, $\chi^2(130) = 156.24$, $p = 0.06$, RMSEA = 0.004, CFI = 0.99. Higher average cigarette use (intercept) was associated with poorer academic performance, greater academic unpreparedness, poorer mental health, poorer physical health, poorer social functioning, greater endorsement of physical ailments, and greater delinquency at wave 8. Additionally, the slope for cigarette use predicted academic performance (with negative slopes associated with poorer academic performance) and physical ailments (with positive slopes associated with greater reported physical ailments).

Racial/ethnic differences for wave 8 outcomes controlling for cigarette use trajectories

We examined direct effects from race/ethnicity to functioning, controlling for both the average (intercept) and rate of change (slope) of probability of cigarette use across waves 1–8. Models also controlled for age, gender, mother's education, and intervention group at wave 1. These models can be interpreted as a test of the association between race/ethnicity and outcomes at wave 8, assuming all groups demonstrated the same trajectories (i.e., fixed intercept and slope) of probability of cigarette use over time (waves 1–8). Black, Hispanic, and Multi-ethnic youth all reported lower academic performance compared to White youth (Table 4). Asian, Black and Multi-ethnic youth reported significantly higher academic unpreparedness than White youth. Asian and Multi-ethnic youth reported poorer mental health than White youth. Multi-ethnic and Hispanic (marginally $p = 0.056$) youth reported more physical ailments than White youth. Asian, Hispanic, and Multi-ethnic youth reported

poorer physical health than White youth. Asian youth also reported greater delinquency and poorer social functioning.

Discussion

This longitudinal study extends the literature on adolescent smoking trajectories by examining the association between race/ethnicity, cigarette smoking trajectories, and academic, health, and psychosocial outcomes at the end of high school in a large and racially/ethnically diverse sample of youth. First, as with other work in this area, we found that race/ethnicity was associated with both average probability and rate of change of cigarette use over time.¹¹ Specifically, controlling for socioeconomic status, Asian teens had lower average probability of smoking over the course of adolescence compared to White teens, which is consistent with other studies' findings.^{12,13,16} We also observed racial/ethnic differences in the rate of change in cigarette use over time, such that Hispanic teens showed lower rates of change in probability of smoking compared to White teens. This is also consistent with past research.^{11,18}

As expected, cigarette use during adolescence was associated with poorer outcomes across a range of domains at the end of high school, including lower academic performance, poorer social functioning, poorer mental and physical health, and increased delinquency. In addition, greater increases in probability of smoking over time (i.e., more positive slope) were associated with endorsement of more physical impairments. Findings are similar to the broader literature on smoking's deleterious effects on a range of outcomes in emerging adulthood (mental and physical health, social functioning and participation in delinquent behaviors and other health risk behaviors like alcohol and other drug use),¹⁻⁵ and highlight that these negative effects are already observable in high school.

To expand beyond prior work, we examined how cigarette use over the course of adolescence differentially affects outcomes at the end of high school across racial/ethnic groups. Controlling for cigarette use trajectories (intercept and rate of change of probability of cigarette use over time), and adjusting for socioeconomic status (mother's education), racial/ethnic minority youth showed poorer outcomes in academic functioning, physical ailments, mental and physical health, and delinquency, compared to their White peers. In particular, Asian, Hispanic, and Multi-ethnic youth showed poorer outcomes in multiple domains-notably physical health and physical impairments. This finding is similar to our trajectory work with AM use, whereby Asian and Multi-ethnic youth reported poorer physical health after controlling for AM use.⁷ However, compared to AM use, cigarette smoking during adolescence appears to be more strongly associated with impaired functioning across multiple domains for racial/ethnic minority youth in late adolescence compared to their White peers. Without intervention, such early disparities may set the stage for poorer functioning over the course of these individuals' adult lives.^{33,34} Thus, assessing for cigarette smoking among racial/ethnic minority youth during the middle and high school years may be critical for identifying youth who may benefit from early interventions aimed at reducing risk behaviors. Such efforts could be instrumental in preventing and reducing disparities across racial/ethnic groups as youth enter adulthood.

The disparities we observed likely arise from numerous interrelated factors. Although models controlled for effects of socioeconomic status (mother's education) on outcomes, it is likely that smoking interacts with a host of other factors related to race/ethnicity^{10–12} to shape more negative outcomes for racial/ethnic minority youth. Racial/ethnic minority teens may be exposed to unique social and environmental stressors, including discrimination and victimization, neighborhood safety concerns, acculturation stressors, and economic stressors.^{33,35} Each of these could influence smoking behavior during adolescence and/or exacerbate negative effects of smoking on a range of outcomes. In addition, cigarette smoking tends to cluster with other risky behaviors (e.g., delinquency, alcohol and other drug use) that have been shown to predict poorer outcomes.^{1–5,7} Other factors, including participation in preventive health behaviors (e.g., healthy diet, physical activity),³⁴ access to and provision of healthcare services,³⁸ community tobacco control infrastructures,⁹ nicotine metabolism,³⁹ and cultural norms¹⁹ may also influence adolescents' smoking and health, which could affect the association between smoking and outcomes among youth of diverse ethnicities. Because smoking is a relatively low base rate behavior in some racial/ethnic groups, when individuals in these groups *do* smoke, it may be a particularly robust indicator of the presence of other risk factors, such as alcohol, marijuana, or other drug use. It may also signal the *absence* of protective factors, such as family or social support,^{12,36,37} which may in turn place minority youth who smoke at higher risk for negative effects of smoking. In this respect, assessing for cigarette use among racial and racial/ethnic minority youth may be a useful strategy for identifying individuals that may benefit from more comprehensive screening and intervention on both tobacco use and a range of other health risk behaviors.

This study has several limitations. First, all data were self-reported, and smoking was not biochemically validated. However, rates of alcohol and other drug use from these youth are similar to self-reported data from national surveys,⁷ and recent work has shown that self-reported drug use from youth age 18–21 is corroborated by biochemical measures.⁴⁰ We did not examine heaviness or frequency of cigarette use; thus, it is unclear how variations in level of consumption may contribute to ethnic disparities we observed. However, prior studies suggest that White teens tend to smoke more heavily (e.g., more likely to be daily smokers)¹¹ than their racial/ethnic minority peers, so it is unlikely that heavier smoking among racial/ethnic minority adolescents accounts for observed disparities. In addition, we had larger samples of White, Asian, Hispanic and mixed ethnicity youth compared to Black youth; yet we still found statistically significant differences for Black youth compared to White youth. Finally, we were unable to re-contact many youth as they transitioned from middle school to high school. Although we did not find differences on demographics or cigarette and other substance use between youth who dropped out of the study and those who continued to complete surveys,⁷ they could have differed on characteristics that we were unable to measure.

Overall, findings advance current literature on cigarette smoking and racial/ethnic disparities by suggesting that after adjusting for similar use patterns over time, as well as an index of socioeconomic status (mother's education), cigarette smoking during adolescence is associated with poorer outcomes for racial/ethnic minority youth compared to White peers, and these disparities in health, academic, and other functional domains are evident as early as high school. Assessing for smoking in racial/ethnic minority youth during this

developmental period may be critical for identifying youth at particularly high risk for negative outcomes. Targeted interventions to address tobacco use and associated risk behaviors for racial/ethnic minority youth who smoke may help to counter the emergence of disparities across racial/ethnic groups.

Acknowledgements

This work was supported by two grants from the National Institute of Alcohol Abuse and Alcoholism at the National Institutes of Health (R01AA016577 and R01AA020883 to E.J.D.). Funding agencies had no input on study design, interpretation of results, manuscript composition, or decision to submit the manuscript for publication. Dr. Dunbar wrote the first draft of this manuscript. All co-authors made substantive contributions to the final version of the manuscript. We thank the districts and schools who participated and supported this project. We would also like to thank Kirsten Becker and Megan Zander-Cotugno for overseeing the school survey administrations and the web-based surveys, and Dr. Wenjing Huang for her helpful comments on a previous draft of this paper. The authors have no conflicts of interest to disclose.

Abbreviations

SEM   Structural equation modeling

References

1. Chassin L, Presson CC, Pitts SC, Sherman SJ. The natural history of cigarette smoking from adolescence to adulthood in a midwestern community sample: multiple trajectories and their psychosocial correlates. *Health Psychol.* 2000;19(3):223–231. doi: 10.1037/0278-6133.19.3.223. [PubMed: 10868766]
2. Orlando M, Tucker JS, Ellickson PL, Klein DJ. Developmental trajectories of cigarette smoking and their correlates from early adolescence to young adulthood. *J Consult Clin Psychol.* 2004;73(3): 400–410. doi: 10.1037/0022-006X.72.3.400.
3. Tucker JS, Ellickson PL, Orlando M, Martino SC, Klein DJ. Substance use trajectories from early adolescence to young adulthood: A comparison of smoking, binge drinking, and marijuana use. *J Drug Issues.* 2005;35(2):307–332. doi: 10.1177/002204260503500205.
4. Orpinas P, Lacy B, Nahapetyan L, Dube SR, Song X. Cigarette smoking trajectories from sixth to twelfth grade: associated substance use and high school dropout. *Nicotine Tob Res.* 2016; 18 (2): 156–162. doi: 10.1093/ntr/ntv040. [PubMed: 25744961]
5. Ellickson PL, Tucker JS, Klein DJ. High-risk behaviors associated with early smoking: Results from a 5-year follow-up. *J Adolesc Health.* 2001; 28, 465–473. doi: 10.1016/S1054-139X(00)00202-0. [PubMed: 11377990]
6. Weitzman M, Cook S, Auinger P, et al. Tobacco smoke exposure is associated with the metabolic syndrome in adolescents. *Circulation.* 2005; 112, 862–869. doi: 10.1161/CIRCULATIONAHA.104.520650 [PubMed: 16061737]
7. D'Amico EJ, Tucker JS, Miles JNV, Ewing BA, Shih RA, Pedersen ER. Alcohol and marijuana use trajectories in a diverse longitudinal sample of adolescents: examining use patterns from age 11 to 17 years. *Addiction.* 2016;111:1825–1835. doi: 10.1111/add.13442. [PubMed: 27130360]
8. Centers for Disease Control and Prevention (CDC). Health disparities and inequalities report. *MMWR* 2013;62(Suppl 3). <http://www.cdc.gov/MMWR/pdf/other/su6203.pdf>.
9. United States Department of Health and Human Services. Tobacco Use Among U.S. Racial/Ethnic Minority Groups: A Report of the Surgeon General Washington, DC; 1998.
10. Fagan P, Moolchan ET, Lawrence D, Fernander A, Ponder PK. Identifying health disparities across the tobacco continuum. *Addiction.* 2007;102(S2):5–29. doi: 10.1111/j.1360-0443.2007.01952.x.
11. Kandel DB, Kiros GE, Schaffran C, Hu MC. Racial/ethnic differences in cigarette smoking initiation and progression to daily smoking: a multilevel analysis. *Am J Public Health.* 2004;94(1): 128–135. doi: 10.2105/AJPH.94.1.128. [PubMed: 14713710]

12. Shih RA, Miles JNV, Tucker JS, Zhou AJ, D'Amico EJ. Racial/ethnic differences in adolescent substance use: mediation by individual, family, and school factors. *J Stud Alcohol Drugs*. 2010;71(5):640–651. doi: 10.15288/jsad.2010.71.640. [PubMed: 20731969]
13. Singh T, Arrazola RA, Corey CG, et al. Tobacco Use Among Middle and High School Students — United States, 2011–2015. *MMWR Morb Mortal Wkly Rep*. 2016;65(14):361–367. doi: 10.15585/mmwr.mm6514a1. [PubMed: 27077789]
14. Wade B, Lariscy JT, Hummer RA. Racial/Ethnic and nativity patterns of U.S. adolescent and young adult smoking. *Popul Res Policy Rev*. 2013;32(3):353–371. doi: 10.1007/s11113-013-9275-8. [PubMed: 25339787]
15. Griesler PC, Kandel DB. Ethnic differences in correlates of adolescent cigarette smoking. *J Adolesc Health*. 1998;23(3):167–180. doi: 10.1016/S1054-139X(98)00029-9. [PubMed: 9730360]
16. Trinidad DR, Gilpin EA, Pierce JP. Do the majority of Asian-American and African-American smokers start as adults? *Am J Prev Med*. 2004;26(2):156–158. doi: 10.1016/j.amepre.2003.10.008. [PubMed: 14751329]
17. White HR, Nagin D, Replogle E, Stouthamer-Loeber M. Racial differences in trajectories of cigarette use. *Drug Alcohol Depend*. 2004;76(3):219–227. doi: 10.1016/j.drugalcdep.2004.05.004. [PubMed: 15561473]
18. Chen P, Jacobson KC. Developmental trajectories of substance use from early adolescence to young adulthood: gender and racial/ethnic differences. *J Adolesc Health*. 2012;20(2):154–163. doi: 10.1016/j.jadohealth.2011.05.013.
19. Moolchan ET, Fagan P, Fernander AF, et al. Addressing tobacco-related health disparities. *Addiction*. 2007;102(S2):30–42. doi: 10.1111/j.1360-0443.2007.01953.x. [PubMed: 17850612]
20. Johnston LD, O'Malley PM, Miech RA, Bachman JG, Schulenberg JE. Monitoring the Future national survey results on drug use, 1975–2016: Overview, key findings on adolescent drug use. Ann Arbor, MI: Institute for Social Research, The University of Michigan; 2017 <http://www.monitoringthefuture.org/pubs/monographs/mtf-overview2016.pdf>.
21. D'Amico EJ, Tucker JS, Miles JNV, Zhou AJ, Shih RA, Green HDJ. Preventing alcohol use with a voluntary after school program for middle school students: Results from a cluster randomized controlled trial of CHOICE. *Prev Sci*. 2012;13(4):415–425. doi: 10.1007/s11121-011-0269-7. [PubMed: 22311178]
22. Ellickson PL, McCaffrey DF, Ghosh-Dastidar B, Longshore DL. New inroads in preventing adolescent drug use: Results from a large-scale trial of Project ALERT in middle schools. *Am J Public Health*. 2003;93(11):1830–1836. doi: 10.2105/AJPH.93.11.1830. [PubMed: 14600049]
23. D'Amico EJ, Miles JNV, Stern SA, Meredith LS. Brief motivational interviewing for teens at risk of substance use consequences: A randomized pilot study in a primary care clinic. *J Subst Abuse Treat*. 2008;35(1):53–61. doi: 10.1016/j.jsat.2007.08.008. [PubMed: 18037603]
24. Winward JL, Hanson KL, Bekman NM, Tapert SF, Brown SA. Adolescent heavy episodic drinking: Neurocognitive functioning during early abstinence. *J Int Neuropsychol Soc*. 2014;20(2):218–229. doi: 10.1017/S1355617713001410. [PubMed: 24512674]
25. Kroenke KS, Williams RL, Janet BW. Validity of a new measure for evaluating the severity of somatic symptoms. *Psychosom Med*. 2002;64(2):258–266. doi: 10.1097/00006842-200203000-00008. [PubMed: 11914441]
26. Jackson KM, Schulenberg JE. Alcohol use during the transition from middle school to high school: National panel data on prevalence and moderators. *Dev Psychol*. 2013;49(11):2147–2158. doi: 10.1037/a0031843. [PubMed: 23421801]
27. Berwick DM, Murphy JM, Goldman PA, Ware JE Jr., Barsky AJ, Weinstein MC. Performance of a five-item mental health screening test. *Med Care*. 1991;29(2):169–176. doi: 10.1097/00005650-199102000-00008. [PubMed: 1994148]
28. DeWalt DA, Thissen D, Stucky BD, et al. PROMIS pediatric peer relationships scale: Development of a peer relationships item bank as part of social health measurement. *Health Psychol*. 2013;32(10):1093–1103. doi: 10.1037/a0032670. [PubMed: 23772887]
29. Tucker JS, Orlando M, Ellickson PL. Patterns and correlates of binge drinking trajectories from early adolescence to young adulthood. *Health Psychol*. 2003;22(1):79–87. doi: 10.1037/0278-6133.22.1.79. [PubMed: 12558205]

30. Muthén L, Muthén B. Mplus 8 Los Angeles, CA; 2011.
31. Asparouhov T, Muthén B. Weighted least squares estimation with missing data. Los Angeles, CA; 2010.
32. Duncan TE, Duncan SC, Strycker LA, Li F, Alpert A. An introduction to latent variable growth curve modeling: Concepts, issues, and applications. Mahwah, NJ: Lawrence Erlbaum Associates; 1999.
33. Jackson JS. Race and Ethnic Differences in Physical and Mental Health Disparities. Bethesda, MD: National Institute on Drug Abuse; 2004.
34. Hoyt LT, Chase-Lansdale PL, McDade TW, Adam EK. Positive youth, healthy adults: does positive well-being in adolescence predict better perceived health and fewer risky health behaviors in young adulthood? *J Adolesc Health*. 2012;50(1):66–73. doi: 10.1016/j.jadohealth.2011.05.002. [PubMed: 22188836]
35. Myers HF. Ethnicity-and socio-economic status-related stresses in context: an integrative review and conceptual model. *J Behav Med*. 2009;32(1):9–19. doi: 10.1007/s10865-008-9181-4. [PubMed: 18989769]
36. Dornelas E, Patten C, Fischer E, et al. Ethnic variation in socioenvironmental factors that influence adolescent smoking. *J Adolesc Health*. 2005;36(3):170–177. doi: 10.1016/j.jadohealth.2004.01.012. [PubMed: 15737771]
37. Au JG, Donaldson SI. Social influences as explanations for substance use differences among Asian-American and European-American adolescents. *J Psychoactive Drugs*. 2000;32(1):15–23. doi: 10.1080/02791072.2000.10400208. [PubMed: 10801064]
38. Cokkinides VE, Halpern MT, Barbeau EM, Ward E, Thun MJ. Racial and ethnic disparities in smoking-cessation interventions: analysis of the 2005 National Health Interview Survey. *Am J Prev Med*. 2008;34(5):404–412. doi: 10.1016/j.amepre.2008.02.003. [PubMed: 18407007]
39. Benowitz NL, Pérez-Stable EJ, Herrera B, Jacob P. Slower metabolism and reduced intake of nicotine from cigarette smoking in Chinese-Americans. *J Natl Cancer Inst*. 2002;94(2):108–115. doi: 10.1093/jnci/94.2.108. [PubMed: 11792749]
40. Simons JS, Wills TA, Emery NN, Marks RM. Quantifying alcohol consumption: Self-report, transdermal assessment, and prediction of dependence symptoms. *Addict Behav*. 2015; 50, 205–212. doi: 10.1016/j.addbeh.2015.06.042. [PubMed: 26160523]

Implications and Contribution

Racial/ethnic minority youth on similar trajectories of cigarette smoking demonstrated poorer academic functioning, poorer mental and physical health, and higher delinquency compared to White peers. Assessing for adolescent smoking among minority youth may help to reduce disparities in functioning across multiple domains.

Figure 1. Past-month cigarette smoking across waves 1–8 by racial/ethnic groups.

This figure shows the percent of youth endorsing any past-month cigarette smoking within each racial/ethnic group at each wave of assessment.

Table 1.

Sample characteristics

	%/Mean (SD)	Minimum	Maximum
<i>Demographics</i>			
Age (wave 8)	18.33 (0.78)	16	22
Race			
White	20.37		
Asian	20.21		
Black	2.39		
Hispanic	45.48		
Multi-ethnic	10.16		
Other	1.39		
Male	45.87		
Mother's Highest Level of Education			
< High School	14.07		
High School	17.89		
Some College	13.69		
College Degree or Higher	54.35		
<i>Outcomes (wave 8)</i>			
Academic Performance	0.00 (1.62)	-10.48	1.58
Academic			
Unpreparedness	3.10 (2.66)	0.00	12.00
Physical Ailments	1.80 (1.40)	0.00	4.00
Physical Health	9.62 (2.18)	0.00	12.00
Mental Health (MHI-5)	65.26 (20.42)	0.00	100.00
Social Functioning	42.92 (8.26)	17.68	52.64
Delinquency	8.42 (3.49)	1.00	20.00
<i>Past-Month Cigarette Use</i>			
Wave 1	1.00		
Wave 2	1.96		
Wave 3	1.89		
Wave 4	2.24		
Wave 5	2.87		
Wave 6	3.83		
Wave 7	6.16		
Wave 8	10.55		

Note. For Academic Performance, each individual item was standardized (mean=0, SD=1), resulting in possible negative scores. For Social Functioning, scores of 0 to 35 were converted to z-scores per the scoring instructions.

Table 2.

Parameter estimates of race/ethnicity predicting cigarette intercept and slope

Race/Ethnicity	Cigarette Use Trajectory (waves 1–8)	
	Intercept	Slope
White (reference)	-	-
Asian	-0.40 (-0.53, -0.27)***	0.00 (-0.05, 0.05)
Black	-0.13 (-0.36, 0.10)	-0.05 (-0.15, 0.04)
Hispanic	-0.02 (-0.11, 0.07)	-0.05 (-0.09, -0.02)**
Multi-ethnic	-0.00 (-0.13, 0.12)	0.03 (-0.02, 0.08)
Other	-0.13 (-0.47, 0.21)	-0.07 (-0.22, 0.07)

Note. Standardized parameter estimates with 95% CI (lower, upper) are from latent growth models with logistic function examining race/ethnicity as a predictor of slope and intercept of past-month cigarette use, controlling for age, gender, mother's education, and intervention group at wave 1. Intercept represents average probability of use. Slope represents the change in probability of use over time. Significance at 0.01 denoted (**) and at .001 denoted (***).

Table 3.

Parameter estimates of cigarette use predicting wave 8 outcomes

Outcome	Cigarette Use Trajectory (waves 1–8)	
	Intercept	Slope
	Estimate (95% CI)	Estimate (95% CI)
<i>Academic Performance</i>	−0.15 (−0.24, −0.07)***	−0.16 (−0.30, −0.02)*
<i>Academic Unpreparedness</i>	0.11 (0.03, 0.20)**	−0.02 (−0.16, 0.12)
<i>Delinquency</i>	0.14 (0.06, 0.21)***	0.01 (−0.11, 0.15)
<i>Mental Health</i>	−0.13 (−0.22, −0.05)**	−0.05 (−0.20, 0.11)
<i>Physical Ailments</i>	0.09 (0.02, 0.17)*	0.24 (0.11, 0.38)*
<i>Physical Health</i>	−0.11 (−0.18, −0.05)**	−0.02 (−0.14, 0.10)
<i>Social Functioning</i>	−0.09 (−0.17, −0.02)*	0.09 (−0.05, 0.23)

Note. This table shows standardized parameter estimates and 95% CI (lower, upper) with significance at 0.05 denoted (*), at 0.01 denoted (**), and at 0.001 denoted (***). Models assessed direct effects of both slope and intercept of cigarette use trajectories from waves 1–8 to each outcome, controlling for age, race/ethnicity, mother's education, and intervention group at wave 1.

Parameter estimates for direct effects of race/ethnicity on wave 8 outcomes, controlling for cigarette use trajectories

Table 4.

Race/Ethnicity	Academic Performance	Academic Unpreparedness	Delinquency	Mental health	Physical Ailments	Physical health	Social Functioning
White (ref)	-	-	-	-	-	-	-
Asian	-0.03 (-0.08, 0.03)	0.09 (0.03, 0.14)**	0.07 (0.02, 0.12)**	-0.08 (-0.13, -0.03)**	0.02 (-0.03, 0.08)	-0.07 (-0.12, -0.02)**	-0.06 (-0.11, -0.01)*
Black	-0.07 (-0.13, 0.00)*	0.07 (0.01, 0.12)*	0.01 (-0.04, 0.06)	0.03 (-0.02, 0.08)	0.01 (-0.04, 0.07)	-0.00 (-0.06, 0.05)	-0.04 (-0.09, 0.01)
Hispanic	-0.10 (-0.17, -0.03)**	0.04 (-0.02, 0.11)	0.04 (-0.02, 0.10)	-0.02 (-0.08, 0.05)	0.06 (0.00, 0.12)#	-0.09 (-0.15, -0.03)**	-0.03 (-0.09, 0.03)
Multi-ethnic	-0.05 (-0.09, -0.01)*	0.07 (0.02, 0.11)**	0.03 (-0.01, 0.07)	-0.06 (-0.10, -0.02)**	0.05 (0.01, 0.09)*	-0.07 (-0.11, -0.02)**	-0.02 (-0.06, 0.02)
Other	-0.04 (-0.10, 0.01)	0.02 (-0.03, 0.07)	-0.01 (-0.05, 0.03)	-0.02 (-0.06, 0.02)	0.01 (-0.04, 0.07)	0.01 (-0.04, 0.06)	-0.03 (-0.07, 0.01)

Note. This table shows standardized parameter estimates and 95% CI (lower, upper) with significance at 0.05 denoted (*), 0.01 denoted at (**), and marginal significance denoted at (#). Models assessed the direct effect of race/ethnicity to each outcome (White specified as reference group), controlling for both slope and intercept of cigarette use trajectories from waves 1–8, as well as age, mother's education, and intervention group at wave 1.