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Age of Escalation, Educational Attainment, and Smoking Abstinence among 25-34 Years Old U.S. Respondents in PATH Wave 4 Study

A thesis submitted in partial satisfaction of the requirements for the Master's degree

in

Public Health

by

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Professor David Strong

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The thesis of Tingyi Yang is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

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DEDICATION

This thesis is dedicated to those who supported, encouraged, inspired, and challenged me to become a better student and person. The completion of the thesis marks the end of my Master of Public Health education. This would not be the same without the kindness and support from the lovely and brilliant people in my journey. A huge thank you goes to all the professors, friends, and staff that I had the pleasure to meet at the University of California, San Diego. I would also like to dedicate this to my parents, who supported my education selflessly, and my loving partner, Kyle, the kindest and most patient person I have ever known.

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ABSTRACT OF THE THESIS

Age of Escalation, Educational Attainment, and Smoking Abstinence among 25-34 Years Old US Respondents in PATH Wave 4 Study

by

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Master of Public Health

University of California San Diego, 2021

Professor Dennis Trinidad, Chair

Early smoking onset is associated with higher nicotine dependence and increased difficulty to quit smoking. The highest level of education one attains links to both the age of regular smoking escalation and cessation, but whether education is a confounder between the age of escalation and cessation is unknown.

We analyzed a cross-sectional survey from the wave 4 nationally representative Population Assessment of Tobacco and Health (PATH) study and restricted the sample to respondents who had smoked at least 100 cigarettes, escalated to regular smoking before the age of 24, and were under 34 years old at the time of the 2017 survey. Logistical regression analysis was used to investigate the association between the age of smoking escalation (<18 years versus 18-24 years), educational attainment (college degree, some college, and no college), and smoking abstinence (1+ day abstinence and 12+ month abstinence).

We discovered a gradient between the age of escalation and educational attainment: The lower the educational attainment respondents held, the higher the proportion of early onset of smoking escalation observed in this population. Similarly, as the level of education increased, the proportion of respondents who was abstinent 1+ day also increased. However, educational attainment was not associated with successful long-term cessation. We found no evidence that educational attainment predicts 12+ month abstinence in the respondents.

In summary, educational attainment, instead of age of escalation, predicted cigarette abstinence in youth. Future studies should further investigate education and related socioeconomic factors to improve smoking prevention and cessation programs.

CHAPTER I: BACKGROUND AND INTRODUCTION

Smoking is the leading cause of preventable disease and death in the United States (U.S.).[1] Smoking cigarettes increases the risk for a variety of health problems such as cancer, stroke and cardiovascular heart disease, and elevates the chance of mortality from these diseases. Approximately 34 million people, 14% of the population, still smoke cigarettes in the U.S.[1] Although the prevalence of smoking has been declining over the past few decades and the number of smokers who quit cigarettes have been increasing, large smoking-related disparities remain across various groups observed by race-ethnicity, socioeconomic status, and health status.[2] The majority of U.S. smokers experiment with cigarettes before the age of 18 and 80% of them became regular smokers by the age of 21.[3] Once persistent smoking is established, it becomes very difficult to quit, especially for adolescents. Quitting smoking earlier is imperative since it has been found that those who quit smoking cigarettes by the age of 35 can evade almost all health consequences of smoking.[4,5]

Nicotine is the major psychoactive component of tobacco. It activates neurotransmitters in the brain to release dopamine and give the body feelings of pleasure. Persistent smoking eventually desensitizes the nicotinic acetylcholine receptors and makes them less responsive to nicotine stimuli.[6] To maintain the levels of dopamine that the body is used to, smokers need to consume an increasing amount of nicotine and are therefore subject to smoking addiction. Compared to adult brains, the

developing adolescent brain is more sensitive to nicotine, more receptive to rewards from smoking and recognizes fewer risks, thus greatly increasing the chances of progression to nicotine addiction even after the first use.[7]

Therefore, delaying the onset of smoking and helping smokers achieve cessation early are prime objectives for reducing the prevalence of prolonged smoking. To this end, policies such as Tobacco 21 have raised the legal minimum age to purchase cigarettes to 21 years old, with the goal of delaying the age of smoking initiation in the population. A variety of programs and campaigns have been developed to help smokers quit cigarette smoking, such as Freedom From Smoking by American Lung Association which provided resources for cessation,[8] and the Million Hearts Tobacco Cessation Change Package which aimed to improve the U.S. healthcare system for tobacco cessation.[9]

In addition to these prevention and cessation strategies, studies have shown that education is an important factor related to smoking initiation and cessation. Lower academic abilities were found to increase the risk of early smoking initiation.[10] High school students who have higher grades and academic aspirations have a lower prevalence of smoking.[11] Adult smokers with an education level less than college have higher proportions of early onset of regular smoking, compared with those who have a college degree.[12] Compared to those who have a high school education, those who had a college degree show greater willingness to quit smoking and have a higher prevalence of quit attempts.[13] One study found that smokers who had a college degree

are 2.5 times more likely to quit smoking than smokers without a college degree.[14] Several other studies have attested to the link between educational attainment and cessation: In longitudinal studies, respondents with at least a college degree had higher odds of making quit attempts[15,16,], maintaining short-term cigarette abstinent[15,16] and not smoking at follow-up[15] [ref] compared to those who had lower educational levels. In contrast, those with less than a college education were found to have higher odds of smoking at follow-up and reduced odds of successful cessation.[13] Education is indeed a significant predictor of smoking cessation.

Smoking escalation signifies the time window during which someone who has experimented with cigarettes becomes a regular cigarette user (by having smoked more than 100 cigarettes). Thus, the age of escalation tells us when a user became a regular cigarette smoker. It is reasonable to assume that those with an earlier age of escalation, compared to at a later age, are more susceptible to nicotine's influence because they have more time to experiment with cigarettes, smoke persistently, and develop stronger nicotine dependence. Since those with higher education levels are more likely to start smoking at older ages and have more success in quitting, education could be a confounder for the age of escalation and smoking abstinence.

This thesis examines how educational attainment affects the relationship between the age of cigarette smoking escalation and cigarette abstinence. To answer this question, we use the wave 4 cross-sectional survey data from the Population Assessment of Tobacco and Health (PATH) study.[18] We were able to access de-

identified information in the Public Use File and analyze the age of regular smoking onset, abstinence patterns, educational attainment, and standard demographic characteristics of adult respondents under age 35 who have smoked more than 100 cigarettes in their lifetime. We are also interested in exploring how early escalators and late escalators may differ in smoking cessation and how this association is influenced by one's educational attainment.

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CHAPTER II: MANUSCRIPT IN STYLE OF JOURNAL

Age of Escalation, Educational Attainment, and Smoking Abstinence among 25-34 Years Old US Respondents in PATH Wave 4 Study

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Implications:

Early escalation of smoking was four times more likely among those who did not go to college compared with college graduates. And it was educational level and not age of escalation that predicted which young adult ever smokers were abstinent at the survey. To better prevent early escalation, we may need to better understand the environmental norms for smoking among those who don't attend college.

Abstract

Introduction:

People who escalate to regular smoking during their adolescence may be more nicotine dependent and less able to quit smoking than those who escalate during young adulthood. However, this could be confounded by educational attainment.

Methods:

Using Wave 4 of the nationally representative Population Assessment of Tobacco and Health (PATH) Study, we limited our sample to ever regular smokers age 25-34 years. We categorized age of escalation into two groups, <18 years and 18-24 years, and educational attainment into three groups: college degree, some college, and no college. We report short term abstinence and 12+ month successful cessation using weighted estimates and conduct adjusted logistic regression with standard demographic covariates.

Results:

Lower levels of education were found among the proportion of the population who escalated to regular smoking before age 18 versus after 18, with those with no college having 4 times the odds of college graduates (AOR=3.91, 95% CI: 3.06-4.98). Educational attainment, but not age of escalation, was associated with being cigarette abstinent (1+ day) at the 2017 survey. Compared college graduates, those with no college education were 80% less likely of being 1+ day abstinent (AOR=0.18, 95%CI:

0.13-0.27). However, educational attainment was not a significant predictor of being quit 12+ months at the survey.

Conclusions:

Early escalation to regular smoking is not associated with later quitting as it is confounded by educational attainment. While educational level is strongly associated with abstinence in the <35 year old population, it is not associated with the proportion of successful cessation.

Keywords: Trajectory, Initiation, Smoking Cessation, Education, Cigarette Smoking.

INTRODUCTION

The majority of those who become US adult cigarette smokers have their first cigarette before age 18 years with the vast majority of those who progress to regular smoking doing so by age 24 years.[1] Multiple studies reporting on trajectories of cigarette initiation separate the adult dependent population into early escalators versus those who were late.[2] Concern has been expressed for early escalators as nicotine is a psychoactive drug and adolescence is a time of considerable attentional brain development.[3,4] There is suggestive evidence that early escalators have a higher incidence of nicotine dependence[5] and a diminished probability of successfully quitting at a young age.[6,7]

Once nicotine dependence is established in young smokers, most may not be able to quit successfully for at least two decades.[8] Quitting before age 35 years has been identified as essential to avoid the majority of the health consequences of smoking.[9,10] Almost all studies of smoking behavior prior to age 35 years have emphasized a strong gradient with formal educational attainment,[1] whether the variable be age of first use[11] or the prevalence of daily smoking[12] or the proportion of the population who have quit (quit ratio).[13] Adolescent smoking patterns and behaviors are established as early as high school and the prevalence of smoking is significantly lower in college-bound high school seniors versus non college-bound seniors.[14] College bound high school students liked school more, were less rebellious and had less time to hang-out with peers who approve of smoking.[15] The difference in smoking rates accelerates as college-bound students enter and stay in college.[6] Those who do not go

to college are more likely to work outdoors where there are less smoking restrictions and to be friends with those who have weaker norms against smoking.[16]

In this paper, we use the 2017 replenished sample from the US nationally representative Population Assessment of Tobacco and Health (PATH) Study.[17] We restrict the population to ever smokers who were beyond age 24 years (the time by which most smokers have progressed to regular smoking), but below age 35 years (the target age for early cessation). In this population, we explore how educational attainment is associated with early (<18 years) or late escalation (18-24 years) and how the two variables interact with measures of cessation, whether 1+ day prevalence of abstinence or 12+ months successful cessation, when the risk of relapse over the next year declines to around 10%.[18]

METHODS

Study Design

The U.S. Population Assessment of Tobacco and Health (PATH) study is a nationally representative longitudinal study which sampled the civilian, non-institutionalized U.S. households using mailing addresses with an area probability design.[17,19] Within the households, tobacco users, young adults age 18-24, and African Americans were oversampled for the study. The first survey wave was in 2013 - 2014 when 32,320 adults and 13,651 adolescents completed computer-assisted self-interviews in their homes in front of a trained interviewer. The participants were initially followed-up in annual study waves, each of which retained approximately 70% of the

sample. To adjust for this attrition and re-set the cohort as nationally representative, a replenishment sample of 9,804 additional participants was added to the original cohort for Wave 4. The weighted response rate for the replenishment sample adult interview was 68.0%.[20] This paper uses PATH study data obtained from the Public Use File[19] and includes the subset (n=6,894) of participants who were 25 to 34 years of age when interviewed at Wave 4 (Dec. 2016 – Jan. 2018). As our main hypothesis involved age of escalation to regular tobacco use, we restricted our sample to those respondents who reported having smoked at least 100 cigarettes in their lifetime. We further restricted the sample to those who had escalated before the age of 25, so that all 25- to 34-year-olds in our cohort had had the chance to escalate to fairly regular smoking.

Tobacco Use Measures

Our topic is focused on age of escalation of cigarette smoking. We defined this as the age that a respondent indicated that they became a regular cigarette smoker (n=3,013). This was obtained from two tobacco use questions. The first question asked whether they had ever smoked 100 cigarettes in their lifetime and, if they had, then they were asked the age that they first started smoking cigarettes fairly regularly. This latter question defines our age of escalation variable. As these responses should not vary over time, once respondents had indicated that they had become fairly regular smokers, they were not re-asked these questions on later surveys. We categorized early escalators as those who had reported escalating *before 18 years old* and later escalators as those who escalated between *18-24 years old*. These two categories

comprised 97.4% of all those who had escalated in our 25- to 34-year-old cohort and we restricted our consideration to these two escalation groups.

Cigarette Abstinence at Wave 4

Our entire sample were ever smokers who had, at some time before 25 years old, been regular smokers. In the Wave 4 sample, all respondents were asked the current status question: “Do you now smoke cigarettes every day, some days or not at all”. A “not at all” response defined a respondent as abstinent at least 1 day at the time of the survey. All abstinent former smokers were asked if they had “even one or two puffs” in the past month and for those who were completely abstinent for this period, the same question was asked for the past 12 months. A negative response to this latter question defined a person as 12+ months cigarette abstinent (long term abstinent).

Educational Attainment and Covariate Measures

Sociodemographic covariates were assessed at wave 1 for the original cohort and at wave 4 for the replenishment samples. Sex, race and education attainment at wave 4 were analyzed. Educational attainment contains 5 types of responses which were collapsed into three main levels--- College Degree, Some College, and No College. College Degree represented respondents who received Bachelor’s degrees or advanced degrees. Respondents classified as Some College had either an associate degree or reported some college education but did not receive a degree. Lastly, No College included respondents who were high school graduates, had GED education, or received some high school education or less.

Race/ethnicity was a composite variable comprised of questions of Hispanic (Hispanic, Non-Hispanic) and Race (White alone, Black alone, and Other) identity used to categorize respondents into White (Non-Hispanic White) and Non-White (not Non-Hispanic White) levels.

Analysis Plan

All analyses were conducted in R statistical software (version 3.6.3) [21] with the RStudio overlay (version 1.2.5033).[22] Estimates were weighted using the Wave 4 cross-sectional weight file. Variance estimates for confidence intervals and p-values were calculated using replicate weights constructed using a balanced repeated replications (BRR) procedure with Fay adjustment (ρ=0.3). The 'survey' package[23] was used to analyze the weighted data in R (version 3.6.3). [21]

Sex, race, and educational attainment were compared using weighted proportions between the two age of escalation groups. Logistic regression was performed to determine the association between gender, race, educational attainment, and the age of escalation. Interactions between gender, race, and educational attainment were tested in a separate model. An ANOVA test was used to detect any improvement from adding interactions to regression models.

To examine the difference in the odds ratio of abstinence status by covariates at wave 4, two logistic regression models were used: The first model used two levels of

age of escalation, sex, race, and educational attainment as predictors of abstinence at Wave 4. The second model focused on predictors of the subset of those who were 1+ day abstinent at Wave 4 and using the same predictors of who had been abstinent for 12+ months.

Missing Data:

When a response to the Wave 4 survey question on demographic data, such as race, age, and gender, was not available or unanswered, the response was imputed for the PATH Public Use File from previous survey response of either the individual or the household screener respondent.[18] Participants with missing data that weren't imputed in the data file (n=10) were not included in the regression models. Thus, our final sample size for analysis was 3,003 persons.

RESULTS

Sociodemographics of Early and Late Escalation to Regular Cigarette Smoking

Among respondents who were 25 to 34 years old between December 2016 and January 2018, 3013/6894 (weighted%: 31.1%) were ever regular cigarette smokers. Among the 3003 respondents included in the analysis, 54.6% (95% Confidence Interval [C.I.]: 52.5%-56.7%) had escalated to cigarette smoking before the age of 18 (early escalators), which was 9.2% more common than the 45.4% (95% C.I.: 43.3%-47.5%) who escalated between ages 18 to 24 years (late escalators).(**Table 1**) Females were significantly more likely to be early escalators than males (Females=58.5%, 95% C.I.: 55.7%-61.2%; Males=51.6%, 95% C.I.: 48.6%-54.5%). Among Non-Hispanic Whites,

59.8% (95% C.I.: 57.2%-62.4%) were early escalators which was very different to other race-ethnicities, where only 42.4% (95% C.I.: 38.8%-46.1%) were early escalators. There was also a major difference in age of escalation by formal education received. Only one third (34.2%, 95% C.I.: 29.1%-39.1%) of those who earned a college degree were early escalators, whereas half (51.2% (95% C.I.: 47.7%-54.7%) of those who had some college, and almost two thirds (64.4%, 95% C.I.:61.7%-67.1%) of those with no college training were early escalators.

Sex, race-ethnicity, and educational attainment were each independent predictors of early escalation in a main effects model (**Table 2 Model A**) but there were no significant interactions between them (**Table 2 Model B**). Educational attainment was the major predictor of early escalation. Compared to those with a college degree, early escalation was 2.13 times more likely among those with some college education (AOR=2.13, 95% C.I.: 1.64-2.76) and 3.91 times more likely (95% C.I.: 3.06-4.98) among those with no college education. The ANOVA test returned the deviance of 3.41 and a p-value of 0.69 from the Chi-square test for this model and there was no evidence that Model B accounted for the data better than Model A.

Cigarette Abstinence at Wave 4

We modeled 1+ day abstinence from cigarettes at Wave 4 by sociodemographics and our two age of escalation groups. (**Table 3, Model C).** There was no association observed between the age group of escalation and 1+ day cigarette-abstinence at Wave 4 (AOR = 1.00; 95% C.I.: 0.81-1.25; p= 0.97). Similarly, there was no association

between sex or race-ethnicity in the proportion of the sample who were 1+ day abstinent at Wave 4. However, there was a strong effect by educational attainment. Among college graduates. 59.8% of ever regular smokers were 1+day abstinent at Wave 4, whereas 38.1% with some college education, and 21.5% with no college education were 1+ day cigarette abstinent at wave 4. Compared to those with college degrees, those with some college education were 59% less likely to be cigarette abstinence of (AOR=0.41, 95% C.I.: 0.31-0.56) while those that had not been to college were 82% less likely (AOR=0.18, 95% C.I.: 0.13-0.27) demonstrating a strong graded effect for increased educational attainment.

We then modeled the percent of 1+ day abstainers who were quit 12+ months at Wave 4 (**Table 3 Model D**). Approximately two thirds of Wave 4 cigarette 1+ day abstainers were in this category of successful 12+ month quitting. Again, there was no evidence of any difference in successful 12+ month quitting between early and late escalators (AOR=1.13, 95% C.I.: 0.80-1.60). Nor was there any evidence of a difference by sex, race-ethnicity, or educational attainment in this population.

DISCUSSION

In this nationally representative study, we report that gender, race/ethnicity and education were all strongly associated with the adjusted escalation to regular smoking prior to age 18 years (early escalation). Those with some college education had over twice the odds of being an early escalator compared to college graduates and those who did not attend college had nearly 4 times the odds of being an early escalator.

However, whether these regular smokers had escalated earlier or late in life was not associated with the proportion who were 1+ day cigarette abstinent at the time of the 2017 survey (a point prevalence estimate). Again, educational attainment was strongly associated with the proportion who were 1+ day abstinent. However, when we considered the proportion of these 1+ day abstainers who met the criteria for successful quitting (12+ months abstinent) neither educational attainment nor age of escalation was associated, and neither were gender or race/ethnicity.

That those with lower educational attainment were more represented among the early escalators which was not surprising given previous work indicating the importance of exposure to other smokers, and targeted advertising[24] towards this educational group. Additionally, those planning to attend college have less free time to 'hang-out' with friends (thus putting them at risk of both experimenting and escalating) than those with no such educational plans.[25] Similarly, college education is associated with different job opportunities and those with lower levels of education are less likely to work in indoor settings which have a much higher probability of smoke-free policies.[26]

What was surprising was that all of these environmental influences against smoking did not result in a strong educational effect in the successful quitting data. The proportion of those abstinent from cigarettes who met the successful quitting criteria was not associated with educational attainment (or gender or race/ethnicity). Approximately two thirds of those who were 1+ day abstinent, regardless of sociodemographics, had been abstinent for at least 12 months. This is not incongruent

with studies suggesting that the higher educated have greater success in quitting,[27] as these studies combine both quit attempts and success from the attempts. The higher educated have more attempts and thus are more likely to be quit at any point in time such as the time of our survey. However, having made an attempt, our data suggest that higher education is not sufficient to help a smoker be more successful in quitting smoking for good. Undoubtedly this relates to the strength of nicotine addiction and the difficulties that nearly all smokers have in successful quitting.[28]

Limitations

Although this study is nationally representative, it is only a single cross-sectional survey and as such it is unable to make causal inferences. However, our data do suggest rather strongly that it is education and not age of escalation to cigarette smoking that is associated with abstinence from smoking at any point in time prior to the age 35. As the PATH Study is a major longitudinal study, additional follow-up of this sample can be used to further test these hypotheses. Even though the PATH Study is a very large longitudinal study, when we focus only on a subset such as the 25-34 year old population, sample sizes are not adequate to test hypotheses for African Americans, Asians, Hispanics or other race-ethnicities (with even lower representativeness in the US population) and this is a major limitation. Unmeasured variables such as the levels of nicotine dependence, the length of time an abstainer had quit cigarettes, and multiple product use were not part of the analysis, future studies could examine persistent smoking and abstinence more thoroughly with these variables.

A strength of this study is that it provides reliable estimates using the large sample from the nationally representative PATH study data with its low rates of missing data. We studied the cessation prevalence among ever regular smokers who were age 25-34, which is the age group who will gain the most from smoking cessation. Further, we not only looked at a point prevalence of cigarette abstinence, but the more rigorous successful cessation that required 12+ months abstinence.

CONCLUSION

In this study, lack of college education was strongly associated with escalation to regular smoking before age 18 years. However, we could find no evidence that age of escalation was associated with the probability of early smoking cessation. Among those who became regular smokers, there was a strong graded relationship between the level of education attained and being cigarette abstinent as a young adult under the age of 35 years. Indeed, it was the only socio-demographic variable that we looked at that was associated with cigarette abstinence. However, educational attainment was not significantly associated with which cigarette abstainers had successfully quit.

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Table 1: Sociodemographic Characteristics by Age of Escalation in Lifetime Ever Regular Smokers Who Are 25-34 Years Old at PATH Study Wave 4 Survey

	Age of First Escalation to Smoking Cigarettes Fairly Regularly					
	Age of Escalation <18		Age of Escalation 18-24			
Sociodemographic Characteristics	N	Wtd% (95% CI)	N	Wtd% (95% CI)	Difference%	*P*-value
Overall	1648	54.6 (52.5-56.7)	1355	45.4 (43.3-47.5)	9.2	
Sex						<.001
Female	869	58.5 (55.7-61.2)	617	41.5 (38.8-44.3)	17.0	
Male	779	51.6 (48.6-54.5)	738	48.4 (45.5-51.4)	3.2	
Race/Ethnicity						<.001
White	1203	59.8 (57.2-62.4)	799	40.2 (37.6-42.8)	19.6	
Non-White[a]	445	42.4 (38.8-46.1)	556	57.6 (53.9-61.2)	-15.2	
Educational Attainment						<.001
College Degree[b]	153	34.2 (29.1-39.2)	273	65.8 (60.8-70.9)	-31.6	
Some College	658	51.2 (47.7-54.7)	612	48.8 (45.3-52.3)	2.4	
No College[c]	826	64.4 (61.7-67.1)	462	35.6 (32.9-38.3)	28.8	

Note: The numbers reflect unweighted data from the study sample and the frequencies and confidence intervals of frequencies reflect weighted data. *P*-value reflect results from Chi-square test for categorical differences. [a]The Non-White race/ethnicity includes Hispanic White, Black, Hispanic Black, and Other race and ethnicity categories. [b]College Degree level includes Bachelor's and more advanced degree. [c]No College level includes GED education, high school degree, and less than high school education. In Educational Attainment data, 11 responses were missing in Age of Escalation < 18 group and 8 responses were missing in Age of Escalation 18-24 group.

Table 2: The Odds of Predicting Age of Escalating Before 18 Years Old with Demographic Characteristics Among Ever Escalators Age 25-34 at PATH Wave 4 Survey

	Age of First Escalation <18			
	Model A		Model B	
Regressors	AOR (95% CI)	*P*-value	AOR (95% CI)	*P*-value
Main Effect				
Sex				
Male	Ref		Ref	
Female	1.40 (1.18-1.66)	<.001	1.79 (1.05-3.04)	.04
Race/Ethnicity				
White	Ref		Ref	
Non-White	0.47 (0.38-0.59)	<.001	0.59 (0.32-1.10)	.10
Educational Attainment				
College Degree	Ref		Ref	
Some College	2.13 (1.64-2.76)	<.001	2.40 (1.59-3.61)	<.001
No College	3.91 (3.06-4.98)	<.001	4.87 (3.21-7.39)	<.001
Interaction Terms				
Sex*Race/Ethnicity				
Female*Non-White			0.87 (0.61-1.24)	.44
Sex*Education				
Female*Some College			0.81 (0.44-1.48)	.49
Female*No College			0.76 (0.43-1.34)	.34
Race/Ethnicity*Education				
Non-White*Some College			0.95 (0.48-1.89)	.89
Non-White*No College			0.74 (0.38-1.44)	.38

Note: The Adjusted Odds Ratio (AOR) estimates came from adjusted multivariate logistic regression models on sociodemographic characteristics (gender, race, education attainment) predicting the age of first regular cigarette smoking, age of escalation, prior to 18 years old. The reference group is age of escalation at between 18-24 years old. The models reflected weighted data.

Model A: Age of Escalation ~ Sex + Race + Education Attainment

Model B: Age of Escalation ~ Sex + Race + Education Attainment + Sex* Race + Sex * Education Attainment + Race* Education Attainment

Chi-square test in ANOVA shows no significant improvement from Model B to Model A (p= 0.69).

Table 3: The Number and Odds Ratio of Differences in Cigarette Abstinence among Ever Cigarette Smokers at Wave 4 by Sociodemographic and Age of Escalation to Regular Smoking

	Cigarette Smoking Cessation Status at Wave 4							
	Model C: Cigarette Abstinence at Wave 4				Model D: Percent of Abstainers who were Successful Quitters			
Regressors	N/Total	Wtd% [a]	AOR (95% CI) *	*P*-value	N/Total	Wtd% [b]	AOR (95% CI)	*P*-value
Age of Escalation								
18-24	451/1355	37.4%	*Ref*		271/451	65.5 %	*Ref*	
<18	461/1648	31.3%	1.00 (0.81-1.25)	.97	305/461	69.1 %	1.13 (0.80-1.60)	.49
Sex								
Male	458/1517	32.6%	*Ref*		299/458	68.6%	*Ref*	
Female	454/1486	36.0%	1.10 (0.87-1.34)	.50	277/454	65.8%	0.90 (0.62-1.31)	.59
Race/Ethnicity								
White	611/2002	33.4%	*Ref*		387/611	66.7%	*Ref*	
Non-White	301/1001	35.5%	1.15 (0.93-1.43)	.20	189/301	68.8%	1.08 (0.73-1.60)	.69
Educational Attainment								
College Degree	235/426	59.8%	*Ref*		131/235	61.6%	*Ref*	
Some College	437/1270	38.1%	0.41 (0.31-0.56)	<.001	286/437	68.6%	1.33 (0.90-1.98)	.16
No College	235/1288	21.5%	0.18 (0.13-0.27)	<.001	156/235	71.0%	1.45 (0.96-2.19)	.08

Note: The number reflects unweighted data from the study sample and the frequencies reflect weighted data. The Adjusted Odds Ratio (OR) estimates are from multivariate logistic regression models on the association of sociodemographic characteristics and the age of escalation predicting cessation events at wave 4. No abstinence at wave 4 and no 12-month successful cessation were the reference groups.

[a] Weighted percentage of ever regular cigarette users who reported cigarettes abstinence at Wave 4

[b] Weighted percentage of abstainers at Wave 4 who had not smoked cigarettes for at least 12 months

Model C: Age of Escalation ~ Any Cessation at Wave 4 + Education + Sex + Race

Model D: Age of Escalation ~ 12-Month Cessation + Education + Sex + Race

CHAPTER III: DISCUSSION

In summary, it was found that the educational attainment level was lower among those who escalated to regular smoking at a younger age, and education was indeed a confounder for the age of escalation and cigarette abstinence. Education greatly affected cessation behaviors in that the age at which smokers started smoking regularly did not affect the status of abstinence. However, although those with higher educational attainment were more likely to be abstinent at any time point (1+ day abstinence), they were not more successful at being long-term cigarette abstinent for 12+ months compared to their counterparts with lower levels of education.

These findings suggest that education is an important factor in reducing the prevalence of prolonged smoking in the population. It might be especially significant for smokers who established regular smoking at a younger age. Early cigarette escalators who were not stopped or delayed by early prevention programs are not less likely to quit smoking if they received higher education. Therefore, increasing education could be a good way to reduce the prevalence of smoking and increase the proportion of the population that is abstinent. A previous study also suggested that an increase in access to college education could reduce cigarette smoking by addressing disparities in different subpopulations that have higher tobacco use.[1]

How does going to college prevent people from smoking or help them quit smoking? Cigarette smoking may be frowned upon in the college environment and no-smoking ordinances on campus likely contribute to social norms against smoking.

People in college hang out with peers who do not smoke and follow the social expectation of non-smoking. More than 2082 college and university campuses have had tobacco-free policies in place [2] since 2017 and the number is only growing. Thus, as young adults grow and adapt to the college environment, they may be less likely to initiate smoking and those who smoke may be more encouraged to quit smoking. It has also been shown that, as early as in high school, college-bound students are less likely to smoke than non-college-bound students.[3] This sub-selection of non-smokers and smokers already takes place and will be reinforced in college. Given that college graduates are also more likely to work in an indoor environment that is smoke-free or low in smoking prevalence compared to those without a college degree,[5] the impact of college attendance on smoking behaviors and decisions could extend far beyond the 2 or 4 years of college.

However, there are barriers to obtaining a college education for some segments of the population. Besides a person's academic interest and performance, other socioeconomic factors such as race/ethnicity, household income, education belief in the family, parental educational level, housing stability, peer influence, and other factors could all impact one's educational attainment and smoking patterns. For example, it is noted that populations with incomes below the poverty line have a higher prevalence of smoking than the general public's.[6] It is very crucial to recognize and address the disparity in socioeconomic resources if we want to target education in different populations to address smoking-related problems. Future research on smoking

trajectory and cessation should investigate major socioeconomic factors besides education as the ones mentioned above.

As mentioned in chapter 2, there are some limitations in this study: One cannot infer causality in this cross-sectional study so an additional follow-up of the sample is needed. The sample in our study is only a small subset of the PATH population and the majority of respondents are white. The non-White sample sizes are small which is why we combined all the non-White race-ethnicities. The dissimilarity in sample size did not provide us an adequate representation of every race and ethnicity such as African Americans, Hispanics, Asians, Native Americans, and Pacific Islanders. So we cannot test the hypothesis for them. Lastly, some variables are not included in the study analysis but are worth investigating in future studies including nicotine dependence, the length of time of cessation, and multiple products use. Despite these limitations, our analysis shows a strong association between higher educational attainment and a higher proportion of cessation so we are confident in our results.

This thesis presented that educational attainment, instead of age of escalation, is strongly associated with abstinence from cigarettes. While we recognize that educational attainment is a proxy for the socioeconomic status of a person and SES contributes to the environment that shape a person's smoking beliefs and behaviors, education could be a target for prevention and cessation programs. This information could be useful for policymakers and those who design tobacco prevention programs such as TV commercials and school programs. Our study highlights the importance of

supporting education, not only for one's wellbeing and growth trajectory but also for their health. It is crucial to keep high school smoking prevention programs in place and even significant to keep them in college since some young adults start to experiment with cigarettes in college and they could still develop addiction and long term nicotine dependence.

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