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AGE OF INITIATION OF CIGARETTE USE IN A NATIONALLY REPRESENTATIVE SAMPLE OF US YOUTH, 2013–2017

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Abstract

Importance: Cigarettes are still a commonly used tobacco product among youth despite recent declines in cigarette use.

Objective: The aim of this study was to prospectively estimate the age of cigarette initiation among youth (12–17 years old) overall, by sex and by race/ethnicity.

Design, Setting, and Participants: This cohort study used data from waves 1 through 4 of the nationally representative Population Assessment of Tobacco and Health (PATH) study, conducted

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from September 12, 2013, to January 3, 2018. Two subpopulations of youth were assessed (i) those non-susceptible to cigarette use, and (ii) never users of cigarettes at their first wave of PATH participation. Weighted interval-censoring survival analyses were used to prospectively estimate the age of initiation of cigarette use outcomes. Cox proportional hazard models were used to estimate differences in the age of initiation by sex and by race/ethnicity. Statistical analyses were performed from October 7, 2019, to May 1, 2020.

Exposures: Differences in the age of initiation by sex and race/ethnicity.

Main Outcome(s) and Measure(s): Age of initiation of: susceptibility to cigarette use, ever, past 30-day, and fairly regular cigarette use overall, by sex, and by race/ethnicity.

Results: A total of 15,776 youth never users, and among them, 11,022 youth who were non-susceptible to cigarette use, were included in the study (weighted mean [SE] age, 13.5 [0.01] years; 58.6% [SE, 0.46%] non-Hispanic White; and 51.0% [SE, 0.32%] boys) and 15,776 were never users of cigarettes at their first wave of PATH participation (weighted mean [SE] age, 13.7 [0.01] years; 55.0% [SE, 0.29%] non-Hispanic White; and 51.0% [SE, 0.15%] boys). By age 18, among those who were non-susceptible, 46.2% (95%CI= 44.3– 48.2) became susceptible to cigarette use. Among never users by age 18, 24.3% (95% CI, 20.7%–28.0%) initiated ever cigarette use, 16.4% (95% CI, 14.5%–18.3%) initiated past 30-day cigarette use, and 3.5% (95% CI, 2.3%–4.7%) initiated fairly regular cigarette use. Boys had a higher risk of initiating ever (hazard ratio [HR]=1.21; 95%CI=1.08–1.36) and past-30 day cigarette use (HR=1.27; 95%CI=1.10–1.47) at earlier ages compared to girls. Non-Hispanic White youth had higher risk of an earlier age of initiation of susceptibility to cigarette use (HR=0.77; 95%CI=0.68–0.88), ever (HR=0.59; 95%CI=0.49–0.71), past 30-day (HR=0.64;95%CI= 0.51–0.77), and fairly regular cigarette use (HR=0.25; 95%CI=0.14–0.43) compared to Non-Hispanic Black youth.

Conclusions and Relevance: The results of this cohort study suggest that, despite current interventions and existing laws, a large number of youth initiated cigarette use before the legal age to purchase tobacco products.

Introduction

Identifying the age of initiation of tobacco use has been pivotal to achieving reductions in tobacco use nationwide, as tobacco use remains one of the leading causes of preventable diseases and death in the US.[1,2] According to the 2012 Surgeon General Report, 88.2% of adult daily smokers 30 to 39 years recall initiating cigarette use at or before age 18.[3] Despite laws in place enforcing the minimum age of tobacco sales (18 years until December 2019; 21 years since December 2019), it is evident that youth are able to access tobacco products, including cigarettes.

Susceptibility to cigarette smoking has been identified as a risk factor for smoking initiation before youth start using cigarettes.[4,5] A previous study of the Population Assessment of Tobacco and Health (PATH) study, conducted from September 12, 2013, to December 14, 2014, reported the prevalence of susceptibility to cigarette use among youth (aged 12–17 years) overall (28.6%)[6] and by race/ethnicity (for Hispanic youth: 31.3%; for non-Hispanic Black youth: 30.5%; for non-Hispanic White youth: 26.9%).[6] The 2019 National Youth Tobacco Survey (NYTS) reported cigarette susceptibility by sex (boys, 46.4%; girls, 45.5%).

[7] In addition, previous reports of PATH among youth have reported initiation of ever (3.8%)[8] and past 30-day (1.6%)[8] cigarette use after 1 or 2 years of follow-up,[9] as well as differences by sex and race/ethnicity. Middle and high school students from the 2014–2016 NYTS reported their median recalled age of cigarette initiation as 13 years old, but this finding is prone to recall bias.[10–12]

As the popularity of other tobacco products have been increasing among youth in recent years,[13] nearly all cigarette users initiate before 18 years old,[3] and earlier ages of cigarette use are associated with increased nicotine dependence[3] and higher risk for chronic diseases.[14,15] Therefore, it is necessary to examine the age of cigarette initiation for tobacco control.

Information that has been missing from the previously mentioned studies is the age of cigarette initiation overall, by sex, and by race/ethnicity estimated prospectively using survival analyses with four years of follow-up. Therefore, we conducted secondary analysis of PATH[16] prospectively estimating the age of initiation of cigarettes in youth (aged 12–17 years) for (1) susceptibility to cigarette use, (2) ever use, (3) past 30-day use, and (4) fairly regular use among non-susceptible and never users of cigarettes at their first wave of PATH participation. Fairly regular use is a subjective measure used to identify consistent, committed cigarette use.[17]

Methods

Study Design and Participants

PATH is a nationally representative, longitudinal cohort study of U.S. youth and adults that studies tobacco use behaviors, attitudes and beliefs, and tobacco-related health outcomes.[16] The target population of PATH consisted of individuals 12 years and older across the U.S., and 13,651 youth (12–17 years) completed wave 1 (September 12, 2013, to December 14, 2014). Our study includes 2 subpopulations: (1) youth aged 12–17 years who were non-susceptible to cigarette use at their first wave of PATH participation (waves 1–3), and (2) youth aged 12–17 years who were never cigarette users at their first wave (waves 1–3) of PATH participation. In addition, youth aged 9–11 years at wave 1 were considered “aged-up youth” when they turned 12 years old and were eligible to participate in the study at waves 2–3; 2,091 and 2,045 “aged-up youth” were included in our study at waves 2 (October 23, 2014, to October 30, 2015) and 3 (October 19, 2015, to October 23, 2016). Youth who turned 18 years of age were invited to complete the adult measurements; 1,915, 1,907 and 1,900 “aged-up adults” completed adult questionnaire from waves 2–4 (October 23, 2014, to January 3, 2018). Data from waves 2 to 4 were used to track outcomes for all participants. Informed oral consent was obtained from the parents of youth participants, and youth provided oral assent.[16] The University of Texas Health Center at Houston granted institutional review board approval (HSC-SPH-17–0368). This report follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines for cohort studies.

Measures

Cigarette Outcomes—The following questions were used to measure susceptibility to cigarette use among non-users of cigarettes across all 4 waves (2013– 2017): (1) “Have you ever been curious about smoking a cigarette?”[18] (2) “Do you think that you will try a cigarette soon?”[18] and (3) “If one of your best friends were to offer you a cigarette, would you smoke it?”[18] Response options for the first question were “very curious”, “somewhat curious”, “a little curious”, and “not at all curious”.[18] Response options for the next two questions were “definitely yes”, “probably yes”, “probably not” and “definitely not”.[18] Respondents who answered “not at all curious” to the first question and “definitely not” to the next 2 questions were considered non-susceptible to cigarette use and any other combination of responses were considered susceptible to cigarette use.

PATH uses a derived variable to represent ever cigarette use (yes/no) at each wave.[18] Past 30-day cigarette use was measured with the question: “In the past 30 days, on how many days did you smoke cigarettes?”[18] Numeric response options included 0–30 days and participants were considered past 30-day cigarette users if they reported 1 or more days. Fairly regular cigarette use (yes/no) was measured with the question: “Have you ever smoked cigarettes fairly regularly?”.[18] For all questions, participants who responded “don’t know” or “refused” were excluded from the analysis.

Sex and Race/Ethnicity as Exposures—PATH imputed the self-reported participant sex variable by using the household information at wave 1 but not at waves 2 and 3,[18] and categorizes participants as boys and girls.[18] The following four categories measured self-reported participant race: White race alone, Black race alone, Asian race alone, and other race (including multi-racial). Participants’ ethnicity was categorized as either Hispanic or non-Hispanic.[18] In order to be comparable to the Surgeon General’s report[3] and previous publications,[9,10,19] investigators combined race and ethnicity to create four categories: non-Hispanic White, Hispanic, non-Hispanic Black, and non-Hispanic other (including multiracial participants).

Age of Initiation—The PATH study provided a derived variable for participant age in years at each wave, because participant date of birth is not included in the restricted-use data.[18] The PATH study provided another derived variable to represent the number of weeks between waves that youth participated in.[18] Participant age was converted from years to weeks and added to the number of weeks between survey dates to give us a more precise estimate of participant age. Lower and upper age bounds were created to identify the age at the last wave when the participant reported non-susceptibility to cigarette use and the age at the first wave when they reported susceptibility to cigarette use. For participants who did not report initiation of susceptibility to cigarette use over the follow-up period (2014– 2017), their upper bound was considered censored. For ever use, past 30-day use and fairly regular use outcomes, the age of initiation was estimated in the same way as susceptibility based on when the outcome was first reported (2014– 2017) for those who become users and the last report of non-use for those who do not.

Statistical Analysis—Secondary analyses of PATH restricted-use datasets were conducted[18] from October 7, 2019 to May 1, 2020 using SAS, version 9.4 (SAS Institute).[20] A type I error level of 0.05 was used, and all *P* values were 2 sided. All data analyses incorporated sampling weights, 100 balance repeated replicate weights and a Fay correction factor of 0.3 to account for the PATH complex study design.[18] Weighted summary statistics (means for continuous variables and proportions for categorical variables) are provided. Weighted interval-censoring survival analysis[21–25] was implemented to estimate the probability of the age of initiation of susceptibility to cigarette use, ever use, past-30 day use, and fairly regular cigarette use. Hazard functions for each cigarette use outcome overall are reported as cumulative percentages and 95% CIs are reported using the Turnbull method.[21–25] Differences in the age of cigarette initiation for each outcome by sex and by race/ethnicity were estimated fitting weighted Cox proportional hazards regression models to interval-censored data with a piecewise constant function as the baseline hazard function.[21–25] Hazard functions and 95% CI are only reported by sex and by race/ethnicity for the outcomes that exhibited statistically significant differences. There was very little missingness in PATH and the number of participants with missing sex or race/ethnicity are reported in Table 1.

Results

A total of 15,776 youth who were never cigarette users and, among them, 11,022 youth who were non-susceptible to cigarette use, were included in the study. Among the 11,022 youth who were non-susceptible to cigarette use, the weighted mean (SE) age was 13.5 (0.01) years, 69.6% (SE, 0.31%) entered the study at wave 1, 58.6% (SE, 0.46%) identified as non-Hispanic White and 51.0% (SE, 0.32%) were boys (Table 1). Among the 15,776 youth who were never users of cigarettes at their first wave of PATH participation, the weighted mean (SE) age was 13.7 (0.01) years, 55.0% (SE, 0.29%) were non-Hispanic White and 51.0% (SE, 0.15%) were boys (Table 1).

Table 2 shows the estimated distribution of the age at initiation of the 4 cigarette use outcomes overall, and eFigure1 in the Supplement shows these hazard functions. Among youth who were non-susceptible to cigarette use, by age 13, 12.4% were estimated to have become susceptible to cigarette use. By ages 18 and 21 years, these estimates were 46.2% and 61.1%, respectively. Among youth who were never cigarette users, by age 18 years, 24.3%, 16.4%, and 3.5% were estimated to initiate ever, past 30-day, and fairly regular cigarette use, respectively.

Table 3 shows the hazard ratios and 95% CIs exploring the differences in the age of initiation of the 4 cigarette use outcomes by sex and by race/ethnicity. We found that boys had a higher risk of initiating ever cigarette use at earlier ages compared to girls (HR: 1.21; 95%CI: 1.08–1.36), as well as past 30-day cigarette use (HR: 1.27; 95%CI: 1.10–1.47). We did not observe statistically significant differences in the age of initiation by sex in susceptibility to cigarette use or fairly regular cigarette use. Non-Hispanic Black youth had 23% (HR: 0.77; 95%CI: 0.68–0.88) less risk to become susceptible to cigarette use at earlier ages compared to non-Hispanic White youth. Non-Hispanic Black youth (HR= 0.59; 95%CI= 0.49– 0.71) and Non-Hispanic other youth (HR= 0.72; 95%CI= 0.59– 0.88) had

lower risk to initiate ever cigarette use at an earlier age compared to Non-Hispanic Whites. Compared with all other racial/ethnic groups, non-Hispanic White youth had a higher risk to initiate past 30-day cigarette use (non-Hispanic Black: HR= 0.64 [95%CI= 0.52– 0.77]; non-Hispanic other: HR= 0.77 [95%CI= 0.63– 0.95]; and Hispanic: HR= 0.82 [95%CI= 0.69– 0.96]) and fairly regular cigarette use (non-Hispanic Black: HR= 0.25 [95%CI= 0.14– 0.43]; non-Hispanic other: HR= 0.67 [95%CI= 0.48– 0.95]; and Hispanic: HR= 0.64 [95%CI= 0.47– 0.87]) at earlier ages than all the other race/ethnicity groups.

Table 4 shows the estimated distribution of the age at initiation for each of the outcomes with statistically significant differences by sex and eFigure2 in the Supplement shows the hazard functions. By age 18 years, 27.4% (95% CI, 24.1%–30.6%) of boys and 17.9% (95% CI, 12.5%–23.2%) of girls reported initiation of ever cigarette use. By age 18 years, 19.0% (95% CI, 16.0%–22.1%) of boys and 13.7% (95% CI, 9.3%–18.2%) of girls reported initiation of past 30-day use.

Table 5 shows the estimated hazard function of the age at initiation for each of the 4 outcomes by race/ethnicity, and eFigure3 in the Supplement shows the hazard function graphically. By age 13 years, 12.7% (95% CI, 11.6%–13.8%) of non-Hispanic White youth, 10.1% (95% CI, 8.7%–11.5%) of Hispanic youth, 10.6% (95% CI, 8.3%–13.0%) of non-Hispanic Black youth, and 15.0% (95% CI, 12.4%–17.5%) of non-Hispanic other youth are estimated to become susceptible to cigarette use. By age 18 years, 14.6% (95% CI, 9.7%–19.5%) of non-Hispanic White youth, 17.8% (95% CI, 16.0%–19.6%) of Hispanic youth, 6.7% (95% CI, 2.4%–11.0%) of non-Hispanic Black youth, and 8.4% (95% CI, 3.2%–13.7%) of non-Hispanic other youth reported initiation of past 30-day cigarette use. The largest increase in initiation of past 30-day cigarette use occurred between ages 17 and 18 years among non-Hispanic White youth (8.5%) and Hispanic youth (9.3%), whereas non-Hispanic Black (7.6%), and non-Hispanic other youth (7.9%) exhibited the largest increase in initiation of past 30-day cigarette use between 18 and 19 years old. By age 20, 8.1% (95% CI, 5.4%–10.8%) of non-Hispanic White youth, 6.4% (95% CI, 3.5%–9.2%) of Hispanic youth, and 7.1% (95% CI, 0.8%–13.4%) of non-Hispanic other youth reported initiation of fairly regular cigarette use.

Discussion

To our knowledge, this study is the first to provide prospective estimates for the distribution of the ages of initiation of 4 cigarette outcomes among youth in the US from 2013 to 2017. Age of initiation of the different cigarette use behaviors is an important factor to explore, and we have identified the ages at which youth are most vulnerable to initiate each cigarette use behavior. Because we prospectively estimated the age of initiation of fairly regular cigarette use among youth, we could not find other studies with which to compare our results, because, to our knowledge, no other studies have been conducted to prospectively estimate the age of fairly regular cigarette initiation.

Between 2013 to 2017, 46.2% of youth who were not susceptible to cigarette use became susceptible by the age of 18 in our study. The result was similar to what was found in the results from the 2019 NYTS, which indicated that 45.9% of middle and high school students

were susceptible to cigarette use.[7] In our study, we did not observe any significant difference in susceptibility to cigarette use between girls and boys, which was consistent with the result of the 2019 NYTS survey.[7] From 2013 to 2017, we observed that by age 18 years, non-Hispanic other youth were most susceptible to cigarette use, followed by Hispanic youth, non-Hispanic White youth and non-Hispanic Black youth. The 2019 NYTS found similar trends, reporting that 49.l% of Hispanic, 46.2% of non-Hispanic other, 45.2% of non-Hispanic White, and 38.3% of non-Hispanic Black middle and high school students were susceptible to cigarette use.[7]

By age 18, 24.3% of youth initiated ever cigarette use in our study. This percentage was slightly higher than the NYTS surveys, which indicated that among middle and high school students, 21% in 2014 to 2016 period had ever used cigarettes.[10] These differences could be due to the longitudinal nature of our study, whereas the NYTS was cross-sectional across multiple years, or due to reporting incidence in our study vs prevalence in NYTS. The 2019 NYTS survey also reported finding significant differences between the prevalence of ever using cigarettes by sex, in which 18.3% of boys had reported ever using cigarettes compared to 14.2% of girls.[7] Our study goes beyond the NYTS results by finding that boys initiate ever cigarette use at earlier ages compared to girls and provides incidence across ages.

We found that non-Hispanic Black and non-Hispanic other youth had later ages of initiation of ever cigarette use compared to non-Hispanic White youth, whereas there were no significant differences observed in the age of initiation of ever cigarette use between non-Hispanic White youth and Hispanic youth. This is different from the NYTS surveys from 2014 to 2017, which found that American Indian and Alaska native youth had the highest prevalence of ever cigarette use (31.4%) followed by native Hawaiian and Pacific Islander youth (29.4%), multiracial youth (24.9%), Hispanic youth (22.2%), non-Hispanic White youth (19.9%), non-Hispanic Black youth (18.0%), and Asian youth (10.3%).[26] However, PATH did not differentiate between these race/ethnicity categories.

We found that by age 18 years, 16.4% had reported initiation of cigarette use in the past 30-days. In contrast, the results from NYTS surveys reported prevalence of past 30-day cigarette use as: (1) 6% in 2014–2016, (2) 5.8% in 2014–2017, and (3) 4.3% in 2019.[7,10,26] We observed significant differences in the age of initiation of past 30-day cigarette use between boys and girls indicating that intervention strategies should start at earlier ages in boys than in girls. The results from 2019 NYTS survey indicated significant differences by sex in past 30-day cigarette use, with 5.1% among boys and 3.4% among girls.[7]. Although a PATH study of waves 1–3 (2013–2016) found that non-Hispanic Black and Hispanic youth had lower odds of initiating past-30 day cigarette use than non-Hispanic White youth,[19] our study goes beyond by reporting the hazard function of past 30-day cigarette use for each racial/ethnic group.

A similar study[27] examining the prospective age of e-cigarette initiation among PATH youth never e-cigarette users found that by age 18 years, 50.2% of youth reported susceptibility to e-cigarettes, 41.7% initiated ever use, 23.5% initiated past 30-day use, and 10.3% initiated fairly regular e-cigarette use. These findings suggest that the age of initiation of each behavior was lower for e-cigarettes than for cigarettes. Tests of significance were not

performed, but these findings add to the body of literature on e-cigarettes as the most popular tobacco product among youth. Another study regarding the age of cigar product initiation among youth found that by age 18 years, 21.1% initiated ever use of any cigars and 11.3% initiated past 30-day use of any cigars,[28] which is lower than the estimates provided for cigarette initiation. A recent national study found that past 30-day cigar use surpasses past 30-day cigarette use[7]; more research is needed to determine the reasons behind these findings.

A recent repeated cross-sectional study examined if the age of cigarette initiation has changed from adolescence (<18 years) to early adulthood (18–23 years) between 2002 to 2018.[29] That study found that the proportion of ever cigarette initiation occurring in early adulthood more than doubled from 20.6% in 2002 to 42.6% in 2018.[29] Additionally, a recent study[30] of PATH aged 26–34 years (who would have been 12–17 years old in the early 2000s) that examined the recalled age of cigarette initiation found that the cumulative proportion of cigarette initiation was 85.8% by age 18 years. This finding is subject to recall bias; however our results that reflect 12–17 year olds between 2013 and 2017 showed that only 24.3% of cigarette initiation occurred by age 18 years, which could be explained by the shifting of cigarette initiation to later ages. Although the age of cigarette initiation may be shifting toward early adulthood rather than adolescence, suggesting that cigarette interventions should be implemented among young adults, our study shows that a high amount of cigarette initiation still occurs among youth. The age of initiation shifting toward later ages could be due to the introduction of e-cigarettes[7], successful interventions targeted towards youth[31,32], or other possible explanations. However, a recent article[33] shows that the introduction of e-cigarettes was followed by a slowing decline in past 30-day cigarette use and acceleration in the ever cigarette use trend between 2004 to 2018. In addition, another article[34] indicates that there was actually no decline in cigarette use because of the introduction of e-cigarettes. More research is needed to determine which of these explanations holds.

There is considerable evidence that earlier ages of cigarette initiation are associated with greater nicotine dependence and greater exposure to nicotine,[35] which can result in adverse health outcomes, including altering brain development among youth[36] and respiratory illnesses.[37] Importantly, previous research has established that nicotine-dependent youth are less likely to want to quit using cigarettes, and youth are uniquely vulnerable to developing nicotine addiction, even at low levels of nicotine use.[38] Interventionists and the public can use our results to identify the particular ages at which the campaigns will be most effective to implement to prevent youth from becoming susceptible to cigarette use and engaging in harmful cigarette use behaviors, such as past 30-day and fairly regular cigarette use.

Strengths and Limitations

Strengths of this study include using a nationally representative dataset and the longitudinal prospective analysis of cigarette initiation outcomes across PATH waves 1 to 4. One of the limitations of our study is that we depended on self-reported data for the cigarette use outcomes to estimate the age of initiation because asking participants the exact date they initiated cigarettes is unrealistic.

Conclusion

To our knowledge, this cohort study is the first to provide prospective estimation of the age of initiation of susceptibility, ever, past 30-day, and fairly regular cigarette use among youth in the US between 2013 and 2017. This study provides windows of opportunity by identifying the ages of 4 cigarette use outcomes in which never users are most likely to initiate cigarette use, including by sex and by race/ethnicity. The results from our study suggest that among those who initiated cigarette use, the onset of the 4 cigarette outcomes occurred for the majority of youth before they were 18 years old (between 16 and 18 years). Because the age of initiation of cigarette use was different by sex and by race/ethnicity, it is important to tailor preventive interventions considering those differences. Boys and non-Hispanic White youth had an increased risk of initiating cigarette use at earlier ages, suggesting tobacco control interventions should focus on these vulnerable subgroups at earlier ages. In December 2019, the government changed the legal age to purchase tobacco products from 18 to 21 years.[39] Though the law did not affect our results, this study provides additional evidence to support the new regulation and can serve as a reference point for age of initiation of cigarette use in future studies after implementation of the Tobacco21 campaign.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Conflict of Interest Disclosures:

Dr Harrell reported receiving personal fees from Robins Kaplan LLP and being a consultant in litigation involving the vaping industry outside the submitted work. Dr Pérez reported receiving grants from the National Institutes of Health and the US Food and Drug Administration Center for Tobacco Products during the conduct of the study. No other disclosures were reported.

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Key Points

Question:

At what age do youth (aged 12–17 years) initiate four cigarette use outcomes (susceptibility to use, ever use, past 30-day use, and fairly regular use)?

Findings:

This cohort study examined nationally representative data for 15,776 youth never users and, among them, 11,022 youth who were non-susceptible to cigarette use, and found that among youth who were non-susceptible to cigarette use, by age 18 years, 46.2% became susceptible to cigarette use. Among never users of cigarettes, 24.4% initiated ever cigarette use, 16.4% initiated past 30-day cigarette use, and 4.3% initiated fairly regular cigarette use.

Meaning:

Study results suggest that prevention interventions and educating the public about targeting specific ages, particularly before 17 to 18 years, may reduce cigarette use initiation.

Table 1.

Demographic characteristics of the PATH USA youth aged 12–17 years who were non-susceptible to cigarette use and never cigarette users at their first wave of study participation (2013–2016).

Total		Non-susceptible to cigarette use at first wave of participation		Never cigarette users at first wave of participation	
		n=11,022; N*=20,687,132	**Weighted % (SE)**	**n= 15,776; N= 29,562,216**	**Weighted % (SE)**
Wave of entry into study	Wave 1	7,879 14,392,886	69.6 (0.31)	11,769 21,448,494	72.5 (0.18)
	Wave 2	1595 3,139,371	15.2 (0.24)	2,021 3,984,220	13.5 (0.13)
	Wave 3	1,548 3,154,875	15.3 (0.34)	1,986 4,129,501	14.0 (0.21)
Age: Weighted mean (SE)		13.5 (0.012)		13.7 (0.007)	
Sex	Boys	5,655 10,544,567	51.0 (0.32)	8,081 15,056,608	51.0 (0.15)
	Girls	5,356 10,116,398	49.0 (0.33)	7,686 14,484,302	49.0 (0.15)
	Missing Values	11 26,167		9 21,307	
Race/Ethnicity	Hispanic	2,218 3,096,942	15.2 (0.20)	4,016 5,789,647	19.8 (0.13)
	Non-Hispanic Black	1,565 2,954,460	14.5 (0.26)	2,223 4,180,658	14.3 (0.14)
	Non-Hispanic Other*	1,162 2,372,797	11.7 (0.27)	1,595 3,221,903	11.0 (0.24)
	Non-Hispanic White	5,873 11,908,783	58.6 (0.46)	7,798 16,104,763	55.0 (0.29)
	Missing Values	204 354,150		144 265,245	

N: estimated national population sizes

*Non-Hispanic Other: Non-Hispanic Asians, Multi-race, etc.

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Table 2.

Hazard Functions in Cumulative Percentages of the Age of Initiation of Cigarette Use Outcomes for PATH Youth Aged 12–17[a]

Age, y	Weighted percentage (95% CI) of cigarette use by age[b]			
	Susceptibility to use	Ever use	Past 30-d use	Fairly regular use
12	0	0	0	0
13	12.4 (11.5–13.3)	0.8 (0.0–1.7)	0.5 (0.2–0.8)	0.2 (0.0–0.5)
14	18.6 (17.6–19.7)	2.9 (2.3–3.5)	1.2 (0.3–2.2)	0.6 (0.1–1.1)
15	25.5 (24.2–26.8)	5.2 (4.8–5.7)	2.2 (1.5–3.2)	1.3 (1.1–1.5)
16	31.3 (30.0–32.7)	8.6 (8.0–9.2)	4.3 (3.6–5.0)	1.4 (0.4–2.4)
17	40.1 (36.3–44.0)	15.4 (14.3–16.5)	9.0 (5.3–12.7)	3.3 (2.0–4.6)
18	46.2 (44.3–48.2)	24.3 (20.7–28.0)	16.4 (14.5–18.3)	3.5 (2.3–4.7)
19	47.9 (45.3–50.4)	25.6 (23.3–27.9)	16.4 (15.2–17.6)	4.3 (3.9–4.8)
20	50.2 (47.9–52.5)	30.8 (28.8–32.8)	20.7 (18.8–22.6)	5.7 (4.6–6.8)
21	61.1 (42.9–79.2)	NA	NA	NA

Abbreviation: NA, not available.

[a]Population Assessment of Tobacco and Health (PATH) Study data reprinted with permission from the United States Department of Health and Human Services.[18] Restricted file received disclosure to publish: February 10, 2020; February 17, 2020; February 28, 2020; March 06, 2020; May 01, 2020.

[b]95% CI indicates Turnbull 95% CI.

Table 3.

Hazard ratios (95% CIs) for different outcomes of age of cigarette initiation stratified by sex and race/ethnicity.

	Susceptibility to use	Ever Use	Past 30-Day Use	Fairly Regular Use
Sex				
Girls	1.00	1.00	1.00	1.00
Boys	0.98 (0.91,1.07)	**1.21 (1.08,1.36)**	**1.27 (1.10,1.47)**	1.21 (0.97,1.50)
Race/Ethnicity				
Non-Hispanic White	1.00	1.00	1.00	1.00
Non-Hispanic Black	**0.77 (0.68,0.88)**	**0.59 (0.49,0.71)**	**0.64 (0.52,0.77)**	**0.25 (0.14,0.43)**
Non-Hispanic Other *	1.08 (0.93,1.25)	**0.72 (0.59,0.88)**	**0.77 (0.63,0.95)**	**0.67 (0.48,0.95)**
Hispanic	0.98 (0.89,1.08)	0.92 (0.80,1.05)	**0.82 (0.69, 0.96)**	**0.64 (0.47,0.87)**

* Non-Hispanic Other: Non-Hispanic Asians, Multi-race, etc.

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Table 4.

Hazard functions[a] in cumulative percentages for age of cigarette initiation outcomes by sex.

Age	Sex			
	Boys	Girls	Boys	Girls
	Initiation of Ever Cigarette Use		Initiation of Past 30-Day Cigarette Use	
12	0	0	0	0
13	1.2 (0.0,2.5)	1.5 (1.1,1.8)	0.4 (0.1,0.6)	0.7 (0.2,1.1)
14	2.8 (1.6,4.1)	3.0 (2.2,3.8)	1.1 (0.0,2.1)	1.4 (0.0,2.9)
15	5.0 (4.4,5.6)	5.5 (4.8,6.2)	1.6 (0.9,2.9)	2.7 (1.9,3.6)
16	8.8 (7.9,9.7)	8.4 (5.5,11.3)	4.3 (3.2,5.4)	4.3 (2.3,6.4)
17	15.9 (9.5,22.4)	14.6 (13.0,16.3)	9.4 (4.5,14.4)	6.3 (2.8,9.7)
18	27.4 (24.1,30.6)	17.9 (12.5,25.5)	19.0 (16.0,22.1)	13.7 (9.3,18.2)
19	27.4 (24.7,30.0)	22.9 (20.3,25.5)	19.0 (17.1,21.0)	13.8 (12.1,15.6)
20	35.7 (32.3,39.2)	25.9 (23.2,28.7)	24.7 (21.8,27.6)	16.7 (14.4,19.1)
21	N/A	N/A	N/A	N/A

*a:*PATH restricted file received disclosure to publish: February 10, 2020; February 17, 2020; February 28, 2020; March 06, 2020; May 01, 2020. United States Department of Health and Human Services. National Institutes of Health. National Institute on Drug Abuse, and United States Department of Health and Human Services. Food and Drug Administration. Center for Tobacco Products. Population Assessment of Tobacco and Health (PATH) Study [United States] Restricted-Use Files. ICPSR36231-v13.AnnArbor, MI: Inter-university Consortium for Political and Social Research [distributor], November 5, 2019. https://doi.org/10.3886/ICPSR36231.v13.

Table 5.

Hazard Functions in Cumulative Percentages (and 95% CIs) for Age of Cigarette Initiation Outcomes by Race/Ethnicity[a]

Age, y	% (95% CI)			
	Non-Hispanic White	Hispanic	Non-Hispanic Black	Non-Hispanic other[b]
Onset of susceptibility cigarette use				
12	0	0	0	0
13	12.7 (11.6–13.8)	10.1 (8.7–11.5)	10.6 (8.3–13.0)	15.0 (12.4–17.5)
14	19.1 (17.6–20.6)	17.6 (15.7–19.5)	15.9 (13.5–18.2)	19.3 (12.0–26.6)
15	25.0 (16.9–33.0)	25.7 (23.4–28.0)	20.6 (17.2–24.0)	27.1 (16.8–37.4)
16	32.1 (30.2–33.9)	30.8 (28.7–33.0)	20.6 (17.9–23.2)	33.5 (24.3–42.7)
17	37.5 (29.1–45.8)	41.4 (34.6–48.2)	27.8 (21.0–34.5)	41.5 (32.8–50.1)
18	46.0 (39.9–52.1)	49.9 (42.9–55.8)	32.5 (28.8–36.2)	49.9 (43.2–56.6)
19	47.6 (44.6–50.5)	49.3 (43.7–54.9)	39.2 (34.7–43.8)	49.9 (43.7–56.1)
20	49.1 (46.2–52.1)	53.9 (50.1–57.6)	44.4 (38.2–50.6)	55.9 (47.4–64.4)
21	NA	63.8 (46.8–80.9)	NA	NA
Initiation of ever cigarette use				
12	0	0	0	0
13	0.9 (0.6–1.3)	1.5 (1.2–1.8)	1.0 (0.0–2.3)	0.9 (0.0–1.8)
14	2.5 (0.1–4.9)	3.3 (2.2–4.4)	2.3 (0.6–3.9)	2.4 (1.4–3.4)
15	5.0 (1.7–8.2)	6.0 (5.3–6.6)	3.0 (1.0–5.0)	3.1 (1.0–5.3)
16	5.0 (4.1–5.8)	10.1 (9.1–11.1)	3.5 (2.4–4.6)	4.3 (2.9–5.7)
17	16.9 (14.6–19.3)	17.1 (12.1–22.2)	6.3 (2.1–10.5)	11.7 (5.1–18.4)
18	25.4 (21.9–28.9)	25.9 (21.1–30.7)	19.2 (5.8–32.5)	13.1 (6.0–20.2)
19	25.4 (22.1–28.7)	28.2 (24.7–31.7)	19.2 (16.2–22.2)	21.9 (16.2–27.7)
20	33.0 (29.2–36.8)	33.4 (30.0–36.8)	21.4 (16.8–25.9)	28.9 (20.8–37.0)
Initiation of past 30-d cigarette use				
12	0	0	0	0
13	NA	0.6 (0.3–0.9)	0.3 (0.1–0.5)	0.7 (0.3–1.1)
14	0.9 (0.5–1.2)	1.1 (0.0–2.3)	0.7 (0.0–1.5)	1.4 (0.3–2.1)
15	1.4 (0.3–2.5)	2.8 (1.7–3.8)	1.1 (0.7–1.8)	1.4 (0.7–2.1)
16	3.2 (0.2–6.2)	5.1 (4.3–5.9)	1.2 (0.6–1.8)	2.4 (1.4–3.5)
17	6.1 (2.1–10.1)	8.5 (3.1–13.9)	4.1 (0.0–8.2)	6.7 (4.0–9.4)
18	14.6 (9.7–19.5)	17.8 (16.0–19.6)	6.7 (2.4–11.0)	8.4 (3.2–13.7)
19	16.1 (13.5–18.7)	18.6 (16.0–21.2)	14.3 (11.7–17.0)	13.5 (9.8–17.1)
20	19.5 (16.2–22.8)	21.8 (19.5–24.0)	18.7 (13.0–24.3)	21.4 (15.1–27.7)
21	NA	NA	NA	NA
Initiation of fairly regular cigarette use				
12	0	0	0	0

Age, y	% (95% CI)			
	Non-Hispanic White	Hispanic	Non-Hispanic Black	Non-Hispanic other[b]
13	0.1 (0.0–0.2)	NA	NA	0.3 (0.0–0.6)
14	0.7 (0.1–1.3)	0.5 (0.2–0.7)[c]	0.2 (0.0–0.4)	0.7 (0.0–1.4)
15	1.8 (1.4–2.1)	0.5 (0.0–1.0)	0.2 (0.0–0.5)	0.7 (0.1–1.3)
16	2.1 (0.5–3.8)	1.8 (0.0–3.5)	1.0 (0.2–1.8)	1.1 (0.3–1.9)
17	4.1 (2.1–6.1)	1.9 (1.3–2.5)	1.1 (0.4–1.8)	2.5 (1.6–3.4)
18	5.4 (3.6–7.1)	2.7 (1.7–3.6)	NA	3.3 (1.5–5.1)
19	5.5 (4.8–6.2)	4.0 (2.6–5.3)	NA	3.6 (1.9–5.4)
20	8.1 (5.4–10.8)	6.4 (3.5–9.2)	NA	7.1 (0.8–13.4)

Abbreviation: NA, not available.

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[b]Non-Hispanic other indicates non-Hispanic Asian participants, multirace/ethnicity, etc.

Supplement.

[c]There was not enough sample size to estimate initiation of fairly regular cigarette use among Hispanic youth at 14 years old, so this age represents 14 years and 12 weeks