METHODOLOGY REPORT OF THE 2019 NATIONAL YOUTH TOBACCO SURVEY

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1.1 Overview of the National Youth Tobacco Survey (NYTS)

In conjunction with the state Youth Tobacco Surveys (YTS), the National Youth Tobacco Survey (NYTS) was developed to provide the data necessary to support the design, implementation, and evaluation of state and national tobacco prevention and control programs (TCPs).[1,2] In addition, NYTS data supplement other existing surveys, such as the Youth Risk Behavior Surveillance System (YRBSS), by providing more comprehensive data on tobacco-related indicators for both middle school (grades 6–8) and high school (grades 9–12) students. Tobacco-related indicators included in the NYTS are: tobacco use (e.g., cigarettes, cigars, smokeless tobacco, electronic cigarettes, hookahs, roll-your-own cigarettes, pipes, snus, dissolvable tobacco, bidis, and heated tobacco products), exposure to secondhand tobacco smoke and e-cigarette aerosol; smoking cessation; minors' ability to purchase or obtain tobacco products; knowledge and attitudes about tobacco; and familiarity with pro-tobacco and anti-tobacco media messages. NYTS data also serve as essential benchmarks against which TCPs can assess the extent of youth tobacco use. The NYTS provides multiple measures and data for six of the 20 tobacco-related Healthy People 2020 objectives: TU-2, TU-3, TU-7, TU-11, TU-18 and TU-19.[3]

First conducted during fall 1999, and again during the springs of 2000, 2002, 2004, 2006, and 2009, then annually starting in 2011, the NYTS provides data that are representative of all middle school and high school students in the 50 states and the District of Columbia. Beginning in 2011, the Centers for Disease Control and Prevention (CDC) and the Food and Drug Administration (FDA) have collaborated to administer the NYTS.

1.2 Overview of the 2019 NYTS Methodology

The 2019 NYTS employed a stratified, three-stage cluster sample design to produce a nationally representative sample of middle school and high school students in the United States. Sampling procedures were probabilistic and conducted without replacement at all stages and entailed selection of: 1) Primary Sampling Units (PSUs) (defined as a county, or a group of small counties, or part of a very large county) within each stratum; 2) Secondary Sampling Units (SSUs), (defined as schools or linked schools) within each selected PSU; and 3) students within each selected school.

After being conducted via paper and pencil questionnaires since its inception in 1999, the NYTS was administered in schools using electronic data collection method for the first time in 2019.

[1] Centers for Disease Control and Prevention. (CDC) (2014). *Best Practices for comprehensive tobacco control programs-2014*. Atlanta, GA: US Department of Health and Human Services, Public Health Service, CDC.

[2] Centers for Disease Control and Prevention. Surveillance and Evaluation Data Resources for Comprehensive Tobacco Control Programs. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014.

[3] US Department of Health and Human Services. Healthy people 2020. Topics and objectives: tobacco use; 2019. Available at https://www.healthypeople.gov/2020/topics-objectives/topic/tobacco-use/objectives.

Participants were provided with a tablet to complete the survey; data were collected offline using a programmed survey application; a single class period of approximately 35-45 minutes was allotted to complete the survey. Survey administrators later established secure WiFi connections to sync all locally stored tablet data to a central repository via encrypted transmissions. Absent students and whole classes unavailable on the day of survey administration could participate in make-up surveys using a web-based version of the questionnaire programmed to mimic the tablet-based application.

Participation in the NYTS is voluntary at both the school and student levels. At the student level, participation was anonymous. CDC's Institutional Review Board (IRB) requires that parents be given the opportunity to opt their student out of participating in the survey. Schools used either passive or active permission forms at their discretion.

Survey administration occurred from February 15, 2019 to May 24, 2019. The final sample consisted of 325 schools, of which 251 participated, yielding a school response rate of 77.2%. A total of 19,018 student questionnaires were completed (17,197 tablet-based; 1,821 web-based) out of a sample of 22,153 students, yielding a student response rate of 85.8%. The overall response rate, defined as the product of the school-level and student-level response rates, was 66.3%.

A weighting factor was applied to each student record to adjust for nonresponse and for varying probabilities of selection. Weights were adjusted to ensure that the weighted proportions of students in each grade matched national population proportions.

The remainder of this report provides detailed information on the methodology used in the 2019 NYTS sample selection (Chapter 2), data collection (Chapter 3), and weighting of student response data (Chapter 4).

CHAPTER 2—NYTS SAMPLING METHODS

2.1 SAMPLE DESIGN

The objective of the NYTS sampling design was to support estimation of tobacco-related knowledge, attitudes, and behaviors in a national population of public and private school students enrolled in grades 6 through 12 in the United States. More specifically, the study was designed to produce national estimates at a 95% confidence level by school level (middle school and high school), by grade (6, 7, 8, 9, 10, 11, and 12), by sex (male and female), and by race/ethnicity (non-Hispanic white, non-Hispanic black, and Hispanic). Additional estimates also were supported for subgroups defined by grade, by sex, and by race/ethnicity, each within school level domain; however, precision levels varied according to differences in subpopulation sizes.

The universe for the study consisted of all public and private school students enrolled in regular middle schools and high schools in grades 6 through 12 in the 50 U.S. states and the District of Columbia. Alternative schools, special education schools, Department of Defense-operated schools, Bureau of Indian Affairs schools, vocational schools that serve only pull-out populations, and students enrolled in regular schools unable to complete the questionnaire without special assistance were excluded. The NYTS employed a repeat cross-sectional design.

The sample was a stratified, three-stage cluster sample. PSUs were stratified by racial/ethnic status and urban versus non-urban designation. PSUs were classified as "urban" if they were in one of the 54 largest Metropolitan Statistical Areas (MSAs) in the United States; otherwise, they were classified as "non-urban." Within each stratum, PSUs, defined as a county, a portion of a county, or a group of counties, were chosen without replacement. Table 2.1 presents key sampling design features.

Table 2.1 Key Sampling Design Features

Sampling Stage	Sampling Units	Stratification	Measure of Size (MOS)	Designed Sample Size
1	PSUs: Counties, portions of a county, or groups of counties	Urban vs. Non-urban (2 strata); Minority concentration (8 strata)	Aggregate school size in target grades	100 Counties, portions of a county, or groups of counties
2	Schools	Small, medium and large; High school vs. middle school	Aggregate eligible enrollment	300 SSUs (school) selections: 200 large schools (2 per PSU), 60 medium schools and 40 small schools
3	Classes/students			2 classes per grade in large schools in 8 black concentrated stratums; 1 class per grade otherwise

With the average design effects attained in the NYTS, the requirements translated to subgroup sample sizes of 1,700 or more. Sample sizes were more than sufficient to generate estimates with the required precision by grade as well as by sex and school level. Therefore, the precision requirements generally focus on racial/ethnic subgroups. As shown in Section 2.8, the requirements are met for the two key minority racial/ethnic subgroups—Hispanics and non-Hispanic blacks—at both the middle and high school levels.

2.2 Sampling Frame

As in previous cycles, the 2019 NYTS sample was based on a comprehensive sampling frame from multiple data sources to increase the coverage of schools nationally. The frame combined data files obtained from Market Data Retrieval, Inc. (MDR, Inc.) and from the National Center for Education Statistics (NCES). The MDR frame contained school information that included enrollments, grades, race/ethnicity distributions within the school, district and county information, and other contact information for public and non-public schools across the nation. The NCES frame sources included the Common Core of Data for public schools and the Private School Survey for non-public schools. This dual-source frame build method was piloted first in 2014 to build the frame for the National Youth Tobacco Survey.[4] Including schools sourced from the two NCES files resulted in a coverage increase among all public and non-public high schools of 23%. Most of the added schools were smaller schools. Efforts were made to ensure that each school was represented only once in the final sampling frame, even if the school showed up in both source files.

Certain schools were removed from the frame prior to drawing the sample following a stepwise process. The first step removed ineligible schools that were classified as Department of Defense schools, vocational schools, and adult education schools. This resulted in the exclusion of 3.2% of schools (2.2% of public schools and 6.3% of private schools) and 0.7% of students. Lastly, schools were removed that had fewer than 40 students enrolled across eligible grades, resulting in the exclusion of 22.6% of schools (8.29% public and 39.03% private) which were eligible after the other exclusions. This exclusion of very small schools led to the exclusion of only 0.8% of students of those in eligible schools.

2.3 Sampling Units and Measure of Size

A three-stage cluster sample design was used to produce a nationally representative sample of students in grades 6–12 who attend public and private schools. The first-stage sampling frame consisted of PSUs made up of counties, groups of smaller, adjacent counties, or parts of larger counties. For the second stage of sampling, secondary sampling units (SSUs) were defined as a physical school that can supply a full complement of students in grades 6 through 8 (middle school) or 9 through 12 (high school) or a school created by linking component physical schools together to provide all grades for the level.

[4] Redesigning National School Surveys: Coverage and Stratification Improvement using Multiple Datasets. William Robb, Kate Flint, Alice Roberts, Ronaldo Iachan, ICF International, FEDCASIC, March 2014

Schools were stratified into small, medium, and large schools based on their ability to support less than one, one or two class selections per grade. Small SSUs contained fewer than 28 students at any grade level, and large SSUs contained at least 56 students at each grade level. The remaining schools were classified as medium sized.

The sampling stages may be summarized as follows:

- Selection of PSUs—One hundred PSUs (from approximately 1,257 PSUs) were selected from 16 strata with probability proportional to the total number of eligible students enrolled in all eligible schools located within a PSU.
- Selection of schools—At the second sampling stage, a total of 200 large schools or SSUs were selected from the 100 sample PSUs. The sample PSUs are subsampled to support the selection of small schools, 40 small schools from 20 subsample PSUs (one school for each level), and medium schools, 60 medium schools from 30 subsample PSUs (one school for each level). This resulted in a total of 300 SSUs (300 = 200+40+60). The PSU subsamples were selected with simple random sampling, and the schools were drawn with probability proportional to the total number of eligible students enrolled in a school.
- Selection of students—Students were selected via whole classes whereby all students enrolled in any one selected class were chosen for participation. Classes were selected from course schedules provided by each school so that all eligible students had only a single chance of selection.

Two classes per grade in large schools and one class per grade in the remaining schools were selected. The threshold for double class sampling was based on a simulation study to ensure that the required numbers of minority students were achieved per school level.

The sampling approach utilized probability proportional to size (PPS) sampling methods with the measure of size (MOS) defined as the count of final-stage sampling units, students in intact classrooms. Coupled with the selection of a fixed number of units, the design resulted in an equal probability of selection for all members of the universe (i.e., a self-weighting sample). These conditions were approximated for the NYTS resulting in the attainment of a roughly self-weighting sample.

The MOS also was used to compute stratum sizes and PSU sizes. By assigning an aggregate measure of size to the PSU, the sample allocated to the PSU was in proportion to the student population.

The third, and final, sampling stage selected classes within each grade of a sample SSU. All students in a selected class then were selected for the survey.

2.4 PROJECTED SAMPLE SIZES

This section describes the planned sample sizes developed by the design, while Section 8 discusses the sample sizes actually attained in the survey. The NYTS sample size calculations were based on the following assumptions:

- The main structure of the sampling design is consistent with the design used to draw the sample for prior cycles of the NYTS.
- The design included the selection of two large SSUs within each sample PSU, and an additional 60 medium and 40 small schools from subsample PSUs.

Across 14 previous cycles of the NYTS that had concluded at the time of the 2019 NYTS design, school participation had averaged 83.3% with a low of 72.5%. Student participation had averaged 89.9% with a low of 87.4%. The combined response rate (student x school) averaged 74.9%. Historical response rates at both school and student levels guided the sampling design and sample sizes. In calculating the sample sizes, a combined rate of 72% was conservatively assumed. Table 2.2 presents a detailed derivation of the sample sizes *planned* for the 2019 NYTS based on these assumptions.

Table 2.2 Planned Sample Sizes for the 2019 NYTS

PSU	Size	# of SSUs	Number of Schools Sampled	# of Classes per School	# of Students per Class	# of Sampled Students prior to Attrition	# of Participating Students Based on 72% Response Rate
100	Large HS	100	Double classes: 40	8	25	8,000	5,760
			Single classes: 60	4	25	6,000	4,320
	Large MS	100	Double classes: 40	6	25	6,000	4,320
			Single classes:60	3	25	4,500	3,240
	Large Total	**200**				**24,500**	**17,640**
30 (sub-sample)	Medium HS	30	30	4	25	3,000	2,160
	Medium MS	30	30	3	25	2,250	1,620
	Medium Total	**60**				**5,250**	**3,780**
20 (sub-sample)	Small HS	20	20	4	25	2,000	1,440
	Small MS	20	20	3	25	1,500	1,080
	Small Total	**40**				**3,500**	**2,520**
	Overall Total	**270**				**33,250**	**23,940**

One-hundred PSUs were selected, with two large SSUs ("full" schools) selected from each PSU for a total of 200 large SSUs. The estimated sample yield from these large schools was 24,500 students before school and student non-response, leading to an expected total 17,640 participating students in large schools after accounting for non-response.

To provide adequate coverage of students in small schools (those with an enrollment of less than 28 students in any grade) 60 medium SSUs from a subsample of 30 PSUs, and 40 small SSUs from a subsample of 20 PSUs were selected. The expected yield was 3,780 from medium schools and 2,520 students from small schools. In total, the number of participating students was 23,940.

Within each school, one class was selected from each grade to participate in the survey except in high minority schools, where two classes per grade were selected. Note that the set of high-minority schools defined for double class sampling is necessarily a subset of the large schools that can support such double class sampling. For the 2019 NYTS, we implemented double class selection for large schools in 8 black concentrated stratums to enhance the black student yields.

2.5 Forming Sampling Units

2.5.1 Forming primary sampling units (PSUs)

In defining PSUs, several issues were considered:

- Each PSU should be large enough to contain the requisite numbers of schools and students by grade, and small enough so as not to be selected with near certainty.
- Each PSU should be compact geographically so that field staff could go from school to school easily.
- PSUs should be consistent with school and school district definitions (i.e., should not cross or split districts).
- PSUs are defined to contain at least four middle and five high schools.

Generally, counties were equivalent to PSUs, with two exceptions:

- Low population counties were combined to provide sufficient numbers of schools and students.
- High population counties were divided into multiple PSUs so that the resulting PSUs would not be selected with certainty.

The PSU frame was screened for PSUs that no longer met the above criteria. The frame was adjusted by re-combining small counties/PSUs as necessary to ensure sufficient size while maintaining compactness. Near-certainty PSUs were split using an automated procedure built into the sampling program.

2.5.2 Forming secondary sampling units (SSUs)

Single schools represented their own SSU if they had students in each of grades 6 through 8 or in grades 9 through 12. Schools that did not have all eligible grades for the level were grouped together to form a SSU. Linked schools were treated as single schools during sampling.

2.6 Stratification

The PSUs were organized into 16 strata, based on urban/non-urban location and proportion minority enrollment.

- If the percentage of Hispanic students in the PSU exceeded the percentage of non-Hispanic black students, then the PSU was classified as Hispanic. Otherwise it was classified as black.
- If the PSU was within one of the 54 largest MSAs in the United States, it was classified as "urban," otherwise it was classified as non-urban.
- Hispanic urban and Hispanic non-urban PSUs were classified into four density groupings depending upon the percentages of Hispanic students in the PSU.
- Non-Hispanic black urban and non-Hispanic black non-urban PSUs also were classified into four groupings depending upon the percentages of black students in the PSU.

The density grouping bounds were computed using an optimization algorithm[5] that is refreshed each cycle to reflect changes in the racial/ethnic distribution of the student population. The boundaries or cutoffs changed as the frequency distribution ("*f*") for the racial groupings changed from one survey cycle to the next. Table 2.3 presents the stratum boundaries used in the 2019 NYTS.

Table 2.3 Stratum Boundaries: Minority Percentage Cutoffs

Minority Concentration	Density Group	Bounds	
		Urban	Non-urban
Black	1	0%-26%	0%-20%
	2	>26%-40%	>20%-34%
	3	>40%-54%	>34%-54%
	4	>54%-100%	>54%-100%
Hispanic	1	0%-26%	0%-24%
	2	>26%-42%	>24%-48%
	3	>42%-58%	>48%-68%
	4	>58%-100%	>68%-100%

As described earlier, SSUs were stratified into three sizes for small, medium, and large schools.

2.7 Sample Allocation and Selection

The 2019 NYTS was designed to select a sample of 100 PSUs. The PSUs were initially allocated to strata proportional to student enrollment. For this cycle, a nearly proportional PSU allocation was achieved, resulting in gains in sampling efficiency. Table 2.4 shows the actual allocation of the PSU sample to the 16 strata defined by minority density and urban status, alongside a proportional allocation. The initial proportional allocation was slightly modified to ensure that all strata contained at least two PSUs to facilitate accurate variance estimation.

[5] The cumulative square root of "*f*" method developed by Dalenius and Hodges.

Table 2.4 First-Stage Strata and Frame PSU Distribution

Predominant Minority	Urban/Non-urban	Density Group Number	Stratum Code	Student Population	Number of Sample PSUs (Revised)
Non-Hispanic Black	Urban	1	BU1	1,270,183	8
		2	BU2	890,576	5
		3	BU3	270,683	2
		4	BU4	290,375	2
	Non-urban	1	BR1	1,511,813	9
		2	BR2	768,040	5
		3	BR3	545,667	4
		4	BR4	273,748	2
Hispanic	Urban	1	HU1	1,946,984	11
		2	HU2	1,475,655	9
		3	HU3	1,413,611	8
		4	HU4	1,114,118	7
	Non-urban	1	HR1	2,971,743	16
		2	HR2	821,571	5
		3	HR3	577,091	4
		4	HR4	378,629	3

The sample was selected with PPS methods at the first and second stages. With PPS sampling, the selection probability for each PSU is proportional to the PSU's measure of size. Systematic sampling procedures were applied to the stratified frame to select a PPS sample of PSUs:

- Selected 100 PSUs with a systematic random sampling within each stratum. The method applied within each stratum was a sampling interval computed as the sum of the measures of size for the PSUs in the stratum, divided by the number of PSUs to be selected in the stratum.

- Subsampled PSUs for the small school (20 PSUs) and medium school (30 PSUs) sampling of two schools per level in each subsample PSU.

2.8 Sample Sizes Attained in the Survey

The 2019 NYTS attained the target sample sizes in the key analytic subgroups of interest. Tables 2.5a–d show the number of participating students in subgroups defined by gender, grade, and race/ethnicity. Table 2.5d, about race/ethnicity distribution, is presented in two different ways: 1) using the original variable allowing for multiple races and including missing data, and 2) using the imputed variable developed for poststratification which includes complete data. By either measure, the sample led to more than 5,500 Hispanic students. It also led to 2,872 black students using the imputed variable and nearly 2,288 black students using the original variable.

Table 2.5a Sample Sizes by Sex: Number of Participating Students

What is your sex?				
Q2	**Frequency**	**Percent**	**Cumulative Frequency**	**Cumulative Percent**
Male	9803	51.55	9803	51.55
Female	9099	47.84	18902	99.39
Displayed, not answered[6]	116	0.61	19018	100.00

Table 2.5b Sample Sizes by Grade Level: Number of Participating Students

What grade are you in?				
Q3	**Frequency**	**Percent**	**Cumulative Frequency**	**Cumulative Percent**
6th	2944	15.48	2944	15.48
7th	3024	15.90	5968	31.38
8th	2869	15.09	8837	46.47
9th	2790	14.67	11627	61.14
10th	2499	13.14	14126	74.28
11th	2502	13.16	16628	87.43
12th	2306	12.13	18934	99.56
Ungraded or other grade	27	0.14	18961	99.70
Displayed, not answered[6]	57	0.30	19018	100.00

[6] "Displayed, not answered" is a type of missingness specific to an electronic administration that occurs when a student is presented with a question on screen, but that question is not answered; that is, item-level nonresponse.

Table 2.5c Sample Sizes by Race/Ethnicity (Multiple Selection): Number of Participating Students

RECODE: Race/Eth - mult grp				
RACE_M	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NH-White	8536	44.88	8536	44.88
NH-Black	2288	12.03	10824	56.91
Hispanic	5564	29.26	16388	86.17
NH-Asian	861	4.53	17249	90.70
NH-AI/AN	221	1.16	17470	91.86
NH-NHOPI	104	0.55	17574	92.41
Multiple Races	998	5.25	18572	97.65
Missing[7]	446	2.35	19018	100.00

Note: This variable is named *race_m* in the public use data set. The multiple race categories are Hispanic, non-Hispanic (NH) white, non-Hispanic black, non-Hispanic Asian, non-Hispanic American Indian or Alaskan Native (AIAN), and non-Hispanic Native Hawaiian or Pacific Islander (NHOPI). For respondents that identified as more than one race, they were categorized as "Multiple Races".

Table 2.5d Sample Sizes by Race/Ethnicity (Single Selection): Number of Participating Students

RECODE: Race/Eth - no mult grp				
RACE_S	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NH-White	9351	49.17	9797	51.51
NH-Black	2430	12.78	12227	64.29
Hispanic	5564	29.26	17791	93.55
NH-Asian	898	4.72	18689	98.27
NH-AI/AN	225	1.18	18914	99.45
NH_NHOPI	104	0.55	19018	100.00
Missing[7]	446	2.35	446	2.35

Note: This variable is named *race_s* in the public use data set. For respondents that identified as more than one race, they were categorized into a single race with the following hierarchy: Hispanic, white, black, Asian, American Indian/Alaskan Native, and Native Hawaiian/Pacific Islander.

2.9 Sample Validation

[7] Missing is defined as missing due to edit check; a legitimate skip; displayed, not answered; or not displayed.

Following the sample draw, each district and school were called to verify the correct information for each entity.

District validation included confirmation of the following:

- District name
- Name and title of 2018-2019 district superintendent
- District street address used for overnight deliveries, with city name and ZIP code

School validation included confirmation of the following:

- School is operational
- School name and relationship to identified district (if applicable)
- Name and title of 2018-2019 school principal
- School street address used for overnight deliveries, with city name and ZIP code
- Grade levels served during 2018-2019 school year
- Approximate school enrollment
- At least a cumulative total enrollment of 40 students in the grades for which the school was selected
- School is a traditional "brick and mortar" school with traditional school-aged students who are not adults and who attend classes in person throughout the academic year
- School has its own unique student body
- School does not exclusively serve a specialized student population such as English Language Learners or Special Education students

CHAPTER 3—NYTS DATA COLLECTION AND PROCESSING

3.1 SURVEY INSTRUMENT

The NYTS collects data on key short-term, intermediate, and long-term tobacco prevention and control outcome indicators. The 2019 survey instrument included 104 questions. The 2019 NYTS represented the first time the study was conducted using electronic data collection methods rather than traditional paper-and-pencil (PAPI). The questionnaire application was programmed for offline data collection on an Android-based operating system. The survey application was written in HTML5 and JavaScript, and the final application was loaded onto a tablet device. Each student was provided with a tablet for the purposes of taking the survey, and it was returned to the survey administrator at the conclusion of the survey session. Students logged into the application using a randomly-generated, randomly-distributed, five-digit access code that was unique to each user. Each access code was tied in a backend database to its associated school and classroom to facilitate tracking and calculate class and school response rates. After survey administrators left the school, they established a WiFi connection and synced all locally stored data records to a central repository. Data were encrypted in transmission.

The survey followed a skip-pattern logic based on the student's responses to questions about ever and current tobacco product use behaviors. To improve students' sense of privacy, only 1-2 questions were displayed on each screen so that responses to prior questions were not susceptible to observation. Students were given one class period (approximately 35-45 minutes) to complete the survey. Students absent on the day of initial survey administration were asked to complete a make-up session upon returning to school. These students participated using a Web-based version of the questionnaire, which was programmed to mimic the tablet-based application in its look, feel, navigation functions, skip logic, and all other programming features. In addition to make-up sessions with absent students, approximately 55 classes used the Web-based survey for their initial administration due to technical difficulties with the tablets, scheduling conflicts that prevented a class from participating on the same day as other selected classes in the same school, or a stated preference by the school to self-administer without a data collector present.

The length of interview (LOI) was captured for each record and was calculated as the time lapse between the date/time of the first response and the date/time of the last response given. The LOI for tablet-based administration ranged from 19 seconds to 15 hours, with an average of approximately 13 minutes. For Web-based administration, LOI ranged from 10 seconds to 23.5 hours, with an average of approximately 14 minutes. After exclusion of outliers, the average survey completion time for tablet and Web was approximately 13 minutes.[8]

The first five questions on the survey collected student demographic information, and the rest measured a comprehensive set of tobacco-related topics (Appendix A). Specific areas covered by the survey included: prevalence of tobacco product use; knowledge of and attitudes toward tobacco use; exposure to pro- and anti-tobacco media and advertising; minors' access to tobacco products; nicotine dependence; cessation attempts; exposure to secondhand tobacco smoke and e-cigarette aerosol; harm perceptions; exposure to tobacco product warnings; and tobacco use prevention

[8] The average completion time was calculated after dropping outliers with survey duration lengths greater than 80 minutes (n<20).

school curricula. At the beginning of each tobacco product section, a description of the product (with example brands) and generic images of specific tobacco products were provided to assist with product recognition and increase the accuracy of student data. Students could refer back to this description as needed as they answered related questions.

Historically, subject matter experts within CDC's Office on Smoking and Health (OSH), Epidemiology Branch have taken the lead on the NYTS questionnaire design. Working in concert with a variety of local, state, and federal stakeholders, including representatives from FDA, CDC reviews the questionnaire prior to each cycle to identify and remove redundancies, examine the most relevant indicators, and obtain guidance and suggestions for new items on the questionnaire.

3.2 External Review and Approvals

Three bodies reviewed and approved the instrumentation, processes, privacy and security elements, and sampling design of the 2019 NYTS: the Office of Management and Budget (OMB), ICF's Institutional Review Board (IRB) and CDC's Institutional Review Board (IRB).

With the transition to an electronic data collection format, a Security Assessment and Authorization (SA&A) application and Enterprise Performance Life Cycle (EPLC) review were completed. The SA&A is a formal methodology for testing and evaluating the security controls of the system to ensure that it is configured properly to meet the security mandated by the Federal Information Security Management Act (FISMA). EPLC is a framework to enhance the Department of Health and Human Services (HHS) IT governance through rigorous application of sound investment and project management principals, in conjunction with industry's best practices.

3.3 Data Collection Staffing

To minimize the amount of data collector travel between home and school assignments, hiring was done geographically across the country, with greater numbers of data collectors in those areas with higher concentrations of sampled schools. Data collectors were recruited from a pool of previously trained data collectors and supplemented with candidates in desired geographic locations. Data collector training was conducted on February 12 – 14, 2019.

Key components of the training included the following:

- Pre-contact activities with the schools
- Entry and exit meetings with school officials
- Data collection protocols
- Recruitment visit protocols
- Follow-up activities
- Communication with headquarters staff

3.4 Recruitment Procedures

The schools selected to participate in the 2019 NYTS were located in 33 different states. Recruitment began in September 2018 with calls to state departments of education and health to inform them of the survey effort and sampled schools in their state. After notification at the state level, district- and school-level recruitment began. Before public or diocesan schools were contacted, verbal or written agreement first was obtained through their district or diocese, respectively; private schools were approached directly. A date for survey implementation was selected to optimize the efficiency of data collection while accommodating school schedules. In selecting a date, convenience to the school and its academic calendar were considered. Additionally, an effort was made to schedule groups of schools from the same school district or PSU around the same time to facilitate efficient travel to and survey implementation within selected schools. For a subset of participating schools, two data collectors needed to be present in order to ensure there were sufficient tablets available for students. Typically, two people were sent to the same school when class enrollments were greater than 35 or when two or more randomly selected classes occurred during the same period. Recruiters used a secure web-based calendar to facilitate communication and to avoid scheduling two schools for the same data collector on the same day.

3.5 Survey Administration

Survey administration in the schools began on February 15, 2019, immediately after a comprehensive data collector training, and continued until May 24, 2019. Each data collector visited an average of three schools per week and traveled with a case of assigned tablets. While the details of each data collection varied, there were eight core steps followed for every school: 1) sync all tablets to access information relevant to an assigned school; 2) pre-contact call with the principal or lead contact prior to arrival at the school; 3) entry meeting with the principal or lead contact; 4) entry meeting with teacher or group of teachers prior to survey administration; 5) survey administration; 6) post-survey meeting with the teacher or teachers; 7) post-survey meeting with the principal or lead contact prior to leaving the school; 8) syncing local records to the central repository. Procedures were designed to protect students' privacy by assuring that student participation was anonymous and voluntary. Students completed the survey via an electronic, tablet-based survey application or a Web-based survey.

3.5.1 Field Procedures

After schools had been recruited, classes selected, and a date for survey administration scheduled, each school received a packet of pre-survey materials containing instructions for the school contact and packets for the teacher of each selected class. Teacher packets contained the parental permission forms to be distributed to all students in the selected classes prior to data collection. The timing of these pre-survey packet mailings was determined in part by the type of permission form being used by the school; this decision was made by the school district or individual school. Passive parental permission forms (i.e., forms returned only if the parents do not want their child to participate) were sent approximately two weeks prior to the scheduled date of data collection in the majority of schools. Active parental permission forms (i.e., forms that must be returned with the parent's signature for the child to participate) were sent out four weeks prior to the scheduled date of data collection for schools that require active consent. Follow-up calls were made to the

selected schools to answer any questions and to make sure materials were received and distributed to selected classes and students.

Trained data collectors were issued a hard shell rolling case holding 30 tablets, a mobile hotspot device for syncing, charging equipment, and extra forms and emergency supply materials. On a rolling basis, data collectors received their assignments electronically for the coming week. In addition, weekly survey supplies that were specific to their assignments (e.g., student sign-in cards) were sent to data collectors' homes or hotels, if traveling.

3.5.2 Classroom Selection

Students were selected for participation by default via the selection of whole classes (i.e., all students enrolled in a selected class were eligible to take the survey). The frames from which classes were chosen were constructed so that eligible students had one, and only one, chance of being selected. However, at times the specific method of selecting classes varied from school to school, according to how a school's class schedule was structured. Typically, classes were selected from a list of required core courses such as English, social studies, math, or science. Among middle school students, and among high school students in a few states, physical education and/or health also were considered core courses. However, in a small number of schools, it was difficult to develop an appropriate frame using this approach. Therefore, in these schools, classes were selected by using a time of day (e.g., second period) when all eligible students were scheduled to be attending a class of one kind or another as the frame, and randomly selecting from all classes held at this time. Lastly, in some schools, homerooms were used as the frame for class selection.

3.6 Web-Based Data Collection Management Application (DCMA)

For multiple cycles of the NYTS, a web-based data collection management application (DCMA) has been utilized to help centralize the management of the study, facilitate information exchange with field staff, and allow all members of the project management, recruitment, and supervisory teams and field staff access to information necessary to implement the study. The system is designed with differing levels of access depending on the user's role on the study. The system's main functions include generating invitation letters, tracking recruitment progress, scheduling data collection, registering student records submitted to the central repository, and tracking school and student response rates.

3.7 Data Syncing and Recording

Preliminary student response rates were recorded by the survey administrators into the DCMA described in Section 3.5. Field staff entered the number of eligible students in each selected class and the expected number of completed records based on their observation in the classroom. Once data were synced, the actual number of records received in the central repository was reflected in student participation reporting. If the number of expected records and the actual number of records differed, project staff verified the correct number and reconciled the discrepancy. As web-based make-ups were submitted by students, the DCMA automatically updated the number of actual records received and participation reporting was revised accordingly.

3.8 RESPONSE RATES

Response rates for the NYTS were calculated at the school and student levels. The goal for weightable data was to have the product of the two response rates equal to or greater than 60%.[9]

3.8.1 School-level Response Rates

At the school level, 325 schools were selected across 224 districts in 33 states. During sample validation, 30 schools were deemed to be ineligible and were replaced.

In total, 251 schools (77.2%) participated in the study. The remaining 74 schools were considered refusals. Of refusals, 42 of them were due to their district refusing to grant access to their schools to discuss participation and 32 were due to refusals at the school level. The most common reasons given for a refusal at the district or school level were loss of instructional time and standardized testing.

3.8.2 Student-level Response Rates

Initial student-level response rates were calculated from the field as data collectors completed survey administration each day. However, as data were received upon syncing and paperwork was received from the field, further refinements were made to: 1) revise the number of eligible students based on available documentation, 2) correct mathematical errors, 3) review counts of surveys received by the database, and 4) account for make-ups as they were received from schools from students and classes that did not participate on the initial day of survey administration.

The final student response rate for the 2019 NYTS was 85.8%. Overall, 22,153 eligible students were invited to participate in the survey, and 19,018 did so. Table 3.1 below shows the number of eligible students, participants, and response rates for the NYTS.

Table 3.1 Overall NYTS 2019 Student Response Rate

	# Eligible	# Completed	Response %
NYTS Participating Students	22,153	19,018	85.8%

When the student response rate is combined with the school response rate, the combined overall study response rate was 66.3% thus considered sufficient for weighting purposes.

The 2019 NYTS survey attained an actual school response rate of 77.2% and a student response rate of 85.9% The overall response rate, the product of the school-level and student-level response rates, was 66.3%.

3.9 DATA MANAGEMENT

Records received via tablet and via web were included in a single national dataset. To take advantage of the electronic format of the NYTS, the dataset was designed to be self-cleaning based on programming logic. However, to ensure accuracy, CDC created a series of data-cleaning

[9] Note that the recruitment goal for the combined school x student response rate is 70%. This is in excess of the combined response rate needed for confidence in weighting.

specifications that were applied to eliminate internal inconsistencies. These cleaning specifications also computed certain analytic variables and re-coded race/ethnicity values to match CDC-specified classifications. Data "missingness" or "blanks" was categorized as a legitimate skip based on programmed logic, as item-level refusal if a question was presented to a student on-screen but not answered, or not answered because the student was never shown a question on screen (e.g., partial complete). Missingness is distinguished in the data set as follows:

- .E – Missing due to edit check
- .S – Legitimate skip
- .N – Displayed, not answered
- .Z – Not displayed

The survey data file preparation for weighting involved a series of data file linking steps. These steps ensured that the data files merged the school information compiled during frame construction, sample selection, replacement of ineligible schools, recruitment, and data collection using a common school identifier.

CHAPTER 4—WEIGHTING OF NYTS RESPONSE DATA

This section describes the procedures used to weight the NYTS data including:

- Sampling weights
- Nonresponse adjustments
- Poststratification to national estimates by grade and weight trimming

This section focuses on the development of the weights for the student response data. The final student-level response data were weighted to reflect the initial probabilities of selection and nonresponse patterns, to mitigate large variations in sampling weights, and to post-stratify the data to known sampling frame characteristics. The section also describes the computation of weighted estimates and variance estimates.

Although the sample was designed to be approximately self-weighting, survey weights were necessary to produce unbiased estimates. The basic weights, or sampling weights, were computed on a case-by-case basis as the reciprocal of the probability of selection of that case. Below is a simple presentation of the basic steps in weight computation.

4.1 SAMPLING WEIGHTS

The base weight is the inverse of the probability of selection for each responding student. The base weight was adjusted to compensate for nonresponse, to alleviate excess weight variation, and to match the weighted data to known control totals. The base weight was computed by inverting the probabilities of selection at each stage to derive a stage weight. For each respondent, the stage weights were multiplied to form the overall sampling weight assigned to each student.

The NYTS computation of sampling weights began at the student sampling stage, and then moved to the school and PSU sampling stages. This sequence allowed the student sampling weights to incorporate adjustments for student nonresponse. These adjustments, described next, used enrollment data by sex and by grade collected for each participating school. Because the process began with the student weights within a given grade, school, and PSU, these weights are referred to as conditional.

4.1.1 Adjusted Conditional Student Weights

The adjusted conditional student weight is the student weight given the selection of the PSU, school, and grade. This weight is the product of the inverse of the probability of selection and a nonresponse adjustment within weighting classes based on grade and sex. Note that this step also includes an approach designed to limit the nonresponse adjustment factor, an early step to avoid extreme weights and hence to control the variability in the weights.

This three-step process is simplified algebraically and computed directly as the ratio of the number of enrolled students to the number of responding students in a given weighting class within a school. The weighting class definition is set dynamically so as to avoid extreme weights, as described next.

The student selection weight is denoted as W^{R}_{cklm}, where the subscripts *k*, *l*, and *m* refer to the school, PSU and stratum as before. The subscript *c* refers to the weighting class, described below. This weight was computed as below, where *N* is the number of enrolled students for each school (the counts are provided by the school during data collection by grade and sex) and *R* is the number of responding students in weighting class *c* within a given school:

$$W^{R}_{cklm} = \frac{N_{cklm}}{R_{cklm}}$$

The weighting class *c* was defined by a sequence of rules that depended on the number of responding students. This was to avoid large weights for classes with low numbers of respondents. This process operated entirely within schools.

Initially, the weighting class was defined by grade and sex within each school. If the weight for the class exceeds a maximum value, *C*, then weighting classes are combined. This cap *C* was computed using the following equation:

$$C_{cklm} = 2\frac{N_{cklm}}{\min(10, N_{cklm})}$$

The combination sequence first grouped males and females within a grade. Both the cap and the weight were then recomputed. If the weight still exceeded the cap, grades were combined. The process was repeated, and if the student weight still exceeded the cap, the school was taken as the weighting class.

This had the effect, within a school, of setting an upper limit on the weight of 2 in weighting classes with an enrollment of less than 10, and 20% of the enrollment in weighting classes with an enrollment of more than 10. Note that the cap could be exceeded, however, in the rare cases where the weighting class was collapsed to the school level.

4.1.2 School Sampling Weights

For large schools, the partial school weight was the inverse of the probability of selection of the school given that the PSU was selected:

$$W^{LS}_{klm} = \left(\frac{MOS_{.lm}}{MOS_{klm}}\right) = \frac{1}{P^{LS}_{klm}}$$

For small schools, the partial school weight was:

$$W^{SS}_{klm} = (100/20)\left(\frac{MOS_{.lm}}{MOS_{klm}}\right) = \frac{1}{P^{SS}_{klm}}$$

For medium schools, the partial school weight for both high schools and middle schools was:

$$W^{MS}{}_{klm} = (100/30)\left(\frac{MOS_{.lm}}{MOS_{klm}}\right) = \frac{1}{P^{MS}{}_{klm}}$$

The overall weights for a given PSU, school and grade combination were the product of the adjusted PSU, school and grade-level weights.

4.1.3 Grade Sampling Weights

Grade selection occurred within linked schools where the grade was available in each of the linked schools, or school "components" that constitute the SSU. The partial weight for a grade, given the selection of the linked school containing it, was simply the inverse of the probability of selection described in Section 2.4. In a non-linked school, the weight was 1.0. The grade weight is denoted as $W^{G}{}_{jklm}$.

4.1.4 PSU Sampling Weights

The weight of the PSU was the inverse of the probability of selection of that PSU:

$$W^{P}{}_{lm} = \frac{1}{K_m}\left(\frac{MOS_{.m}}{MOS_{lm}}\right) = \frac{1}{P^{P}{}_{lm}}$$

For small and medium school selections, the supporting sample PSUs were drawn as a subsample. This PSU subsampling component of the PSU weight was accounted for in the school selection probability and corresponding weight.

4.1.5 Overall Sampling Weight

The overall sampling weight was formed as the product of the stage selection weights. This weight, W^{T1}, was then adjusted for nonresponse, trimmed, and post stratified to control totals, as described in the following sections. This weight was computed as:

$$\begin{cases} W^{T1}{}_{hijklm} = W^{P}{}_{lm} W^{LS}{}_{klm} W^{G}{}_{jklm} W^{R}{}_{hijklm} \\ W^{T1}{}_{hijklm} = W^{P}{}_{lm} W^{MS}{}_{klm} W^{G}{}_{jklm} W^{R}{}_{hijklm} \\ W^{T1}{}_{hijklm} = W^{P}{}_{lm} W^{SS}{}_{klm} W^{G}{}_{jklm} W^{R}{}_{hijklm} \end{cases}$$

For large, medium, and small schools, respectively, where the weights in the latter portions of the equations are defined in the preceding sections.

4.2 Nonresponse Adjustments

Nonresponse adjustment of weights is important to reduce potential bias incorporated into surveys from differences between responding and nonresponding students and schools included in the sample.

4.2.1 Student Nonresponse Adjustment

An adjustment for student nonresponse was made by sex and grade within school. With this adjustment, the sum of the student weights over participating students within a school matched the total enrollment by grade and sex in the school collected during data collection. This adjustment factor was capped in extreme situations to limit the potential effects of extreme weights on the precision of survey estimates.

In the 2019 NYTS cycle, nonresponse adjustment cells were defined in a tailored and systematic approach stemming from the non-response analysis. These analyses are detailed in the *2019 NYTS Nonresponse Bias Analysis* report.

Specifically, the definition of the most appropriate nonresponse adjustment weighting cells followed these steps:

1. Conduct bivariate analysis to identify key predictors of school nonresponse and student nonresponse.
2. Conduct multivariate logistic regression analysis, or response propensity models, including the subset of key predictors identified in No. 1 to identify significant predictors of non-response at both levels.
3. Develop nonresponse adjustment weighting cells based on the significant predictors while incorporating information about cell sizes and correlations between predictors.

During the 2019 cycle, census region and percentage of black students were found to be predictive on nonresponse. Nonresponse adjustment cells were created using -school level (high vs middle), census region (4 levels) and percentage of black students (below vs above median).

Typically, with multiple variables associated with school nonresponse, the subset of variables selected for defining weight adjustment cells is effectively reduced in two ways: 1) by eliminating variables with high pairwise correlations, and 2) limiting to variables and cells with adequate representation of participating schools. Several weight adjustments were used to account for student and school nonresponse patterns. An adjustment for student nonresponse was made by sex and grade within school. With this adjustment, the sum of the student weights over participating students within a school matches the total enrollment by grade and sex in the school collected during data collection. This adjustment factor was capped in extreme situations to limit the potential effects of extreme weights on the precision of survey estimates. If enrollment by grade and sex is not available for certain schools, only adjustments by grade or school level were performed.

The weights of students in participating schools were adjusted to account for nonparticipation by other schools. The adjustment factor (A_m) is the ratio of the sum of weighted MOS of all selected schools in the stratum over the sum of the weighted MOS for participating schools in a stratum. The adjustment factor was computed and applied to public and non-public schools separately.

The adjustment process used the following equations for the adjustment factor:

$$A_m = \frac{\sum_{k,l \in sampled\ schools}(W_{lm}^P * W_{klm} * MOS_{klm})}{\sum_{k,l \in participating\ schools}(W_{lm}^P * W_{klm} * MOS_{klm})}$$

The student weight adjusted for nonresponse was then:

$$W_3^s = W_2^s * A_m$$

Table 4.1 presents the nonresponse adjustment factors within each of the nonresponse adjustment cells. The adjustment cells were defined differently for public and non-public schools. Non-public schools were not partitioned into finer cells; public schools were divided by school level (2 levels), census region (4 categories) and percent of black students (2 levels).

Table 4.1 Nonresponse Adjustment Factors in Each Adjustment Cell

Weighting Class	Weight Sum Over Participants	Responding School Count	Weight Sum over all Sample	Sample School Count	Response Rate (%)	Adjustment Factor
High School, Northeast, Percent of Black below Median	653,080.66	8	941,426.84	10	80.0	1.442
High School, Northeast, Percent of Black above Median	1,035,833.42	9	1,865,232.49	17	52.94	1.801
High School, Midwest, Percent of Black below Median	2,563,113.46	21	2,765,162.77	23	91.30	1.079
High School, Midwest, Percent of Black above Median	1,094,846.90	14	1,393,032.91	16	87.5	1.272
High School, South, Percent of Black below Median	1,163,120.47	10	1,631,635.98	14	71.43	1.403
High School, South, Percent of Black above Median	2,666,833.35	21	3,998,617.04	33	63.63	1.499
High School, West, Percent of Black below Median	2,444,469.04	22	2,917,864.85	25	88.0	1.194

Weighting Class	Weight Sum Over Participants	Responding School Count	Weight Sum over all Sample	Sample School Count	Response Rate (%)	Adjustment Factor
High School, West, Percent of Black above Median	866,199.81	7	1,324,862.62	11	63.63	1.53
Middle School, Northeast, Percent of Black below Median	988,596.15	13	1,309,670.64	16	81.25	1.325
Middle School, Northeast, Percent of Black above Median	827,396.95	12	1,074,522.13	14	85.71	1.299
Middle School, Midwest, Percent of Black below Median	1,558,816.87	18	1,993,281.03	21	85.71	1.279
Middle School, Midwest, Percent of Black above Median	701,752.15	10	1,187,344.32	16	62.5	1.692
Middle School, South, Percent of Black below Median	1,287,739.11	15	1,540,474.99	19	78.95	1.196
Middle School, South, Percent of Black above Median	2,311,484.38	28	3,879,420.47	43	65.12	1.678
Middle School, West, Percent of Black below Median	2,552,788.06	33	2,753,388.13	35	94.29	1.079
Middle School, West, Percent of Black above Median	711,926.50	10	919,436.37	12	83.33	1.291
	23427997.3	**251**	**31495373.6**	**325**		

* The variables considered in the non-response analyses which led to non-response adjustment cells are more fully described in the non-response analysis report. The three variables used in non-response adjustment cells are school level (high vs middle), census region (4 categories) and percentage of black student (below vs above median).

4.3 POSTSTRATIFICATION AND TRIMMING

The final steps in the weighting process include trimming and poststratification. Extreme variation in sampling weights can inflate sampling variances and offset the precision gained from a well-designed sampling plan. Nonresponse adjustments while minimizing bias can add additional variances. One strategy to compensate for these potential effects is to trim extreme weights and distribute the trimmed weight among the untrimmed weights. The trimming is an iterative procedure. It is possible to implement the iterative trimming in conjunction with the iterative poststratification, or raking, procedures described next.

Poststratification approaches capitalize on known population totals and percentages available for groups of schools and students. National estimates of racial/ethnic counts for poststratification were obtained from two sources described next. Private schools' enrollments by grade and five racial/ethnic groups were obtained from the Private School Survey (PSS); public school enrollments by grade, sex, and five racial/ethnic categories were obtained from the Common Core of Data (CCD). Both are produced by the National Center of Education Statistics (NCES); the most recent versions, the 2013–14 CCD and the 2015-16 PSS was used.

These databases were combined to produce the enrollments for all schools and to develop population counts to use as controls in the poststratification step. Iterative poststratification, or raking, methods allowed the use of additional poststratification variables and categories. The iterative approach allowed the simultaneous application of a trimming procedure (see, for example Iachan, 2010).[10] Trimming is designed to limit the variance increase that may follow from the bias-reduction raking methods. The trimming method capped the weights at the median plus four times the interquartile range of the weight distribution.

Tables 4.2 and 4.3 present the population control totals, which also are the sums of the weights in each poststratum cell separately for public and non-public schools by grade and sex and by grade and race/ethnicity, respectively, to reflect the iterations used in the raking procedures.

[10] Iachan, R. (2010, August). *A new iterative method for weight trimming and raking.* Paper presented at the American Statistical Association meeting, Vancouver, Canada.

Table 4.2 Sum of Final Weights vs. Control Total - by Public Flag, Grade and Sex

School Type	Grade	Sex*	Number of Records	Weight Sum = Control Total
Public	6	Male	1362	1,887,823.87
Public	6	Female	1369	1,796,776.13
Public	7	Male	1411	1,918,137.18
Public	7	Female	1416	1,8266,32.82
Public	8	Male	1444	1,912,633.97
Public	8	Female	1224	1,828,214.03
Public	9	Male	1352	2,008,367.98
Public	9	Female	1244	1,884,892.02
Public	10	Male	1207	1,861,825.26
Public	10	Female	1100	1,789,842.74
Public	11	Male	1242	1,711,309.31
Public	11	Female	1118	1,678,618.69
Public	12	Male	1143	1,643,305.91
Public	12	Female	1022	1,628,871.09
Private	6	Combined	210	244,092.00
Private	7	Combined	231	241,805.00
Private	8	Combined	215	236,912.00
Private	9	Combined	196	232,776.00
Private	10	Combined	209	231,500.00
Private	11	Combined	154	226,218.00
Private	12	Combined	149	220,662.00

*Sex is combined for private schools due to small cell sizes.

Table 4.3 Sum of Final Weights vs. Control Total - by Public Flag, Grade and Race

School Type	Grade	Race/Hispanic Origin*	Number of Records	Weight Sum = Control Total
Public	6	Non-Hispanic Native American	73	39,374.42
Public	6	Non-Hispanic Asian and Pacific Islander	149	197,794.42
Public	6	Non-Hispanic Black	398	581,340.65
Public	6	Hispanic	852	961,282.04
Public	6	Non-Hispanic White	1259	1,904,808.47
Public	7	Non-Hispanic Native American	93	40,001.74
Public	7	Non-Hispanic Asian and Pacific Islander	134	197,430.31
Public	7	Non-Hispanic Black	476	593,270.66
Public	7	Hispanic	871	964,625.76
Public	7	Non-Hispanic White	1253	1,949,441.54
Public	8	Non-Hispanic Native American	47	40,234.54
Public	8	Non-Hispanic Asian and Pacific Islander	140	200,029.94
Public	8	Non-Hispanic Black	451	594,425.34
Public	8	Hispanic	819	940,420.61
Public	8	Non-Hispanic White	1211	1,965,737.57
Public	9	Non-Hispanic Native American	44	43,149.08
Public	9	Non-Hispanic Asian and Pacific Islander	151	195,315.11
Public	9	Non-Hispanic Black	410	651,138.66
Public	9	Hispanic	737	978,398.96
Public	9	Non-Hispanic White	1254	2,025,258.20
Public	10	Non-Hispanic Native American	46	39,358.76
Public	10	Non-Hispanic Asian and Pacific Islander	137	194,973.41
Public	10	Non-Hispanic Black	321	579,675.39
Public	10	Hispanic	691	881,161.65
Public	10	Non-Hispanic White	1112	1,956,498.80
Public	11	Non-Hispanic Native American	41	34,874.72
Public	11	Non-Hispanic Asian and Pacific Islander	138	193,666.84
Public	11	Non-Hispanic Black	363	513,086.02
Public	11	Hispanic	663	781,658.91
Public	11	Non-Hispanic White	1155	1,866,641.52
Public	12	Non-Hispanic Native American	18	33,646.81
Public	12	Non-Hispanic Asian and Pacific Islander	147	190,497.87
Public	12	Non-Hispanic Black	308	482,280.82
Public	12	Hispanic	682	725,853.28
Public	12	Non-Hispanic White	1010	1,839,898.23
Private	6	Combined	210	244,092.00
Private	7	Combined	231	241,805.00
Private	8	Combined	215	236,912.00
Private	9	Combined	196	232,776.00
Private	10	Combined	209	231,500.00
Private	11	Combined	154	226,218.00
Private	12	Combined	149	220,662.00

*Race/Hispanic origin is combined for private schools due to small cell sizes.

For poststratification purposes, a unique race/ethnicity was assigned to respondents with missing data on race/ethnicity, those with an "Other" classification, and those reporting multiple races. For

non-public schools, we did not post-stratify by race/ethnic classifications. For public schools we used the full five categories.

The raking and trimming method ensured that final weights sum to the population control totals in each cell while also limiting the coefficient of variation (CV) of the weights. The CV=69.76% implies that the design-effect (DEFF) component due to unequal weighing effects is 1.49.[11]

4.4 Estimators and Variance Estimation

Weighted estimates of means, percentages and totals can be computed using the final weights included in the analysis file. If w_i is the weight of case i (the inverse of the probability of selection adjusted for nonresponse and poststratification adjustments) and x_i is a characteristic of case i (e.g., x_i=1 if student i smokes, but is zero otherwise), then the mean of characteristic x is estimated as $(\Sigma\, w_i x_i)/(\Sigma\, w_i)$. A weighted population total estimate is computed similarly as $(\Sigma\, w_i x_i)$. The weighted population estimates can be computed with the Statistical Analysis System (SAS) as well as with other statistical software.

These estimates are accompanied by measures of sampling variability, or sampling error, such as variances and standard errors, that account for the complex sampling design. These measures support the construction of confidence intervals and other statistical inference such as statistical testing (e.g., subgroup comparisons or trends over successive NYTS cycles). Sampling variances can be estimated using the method of general linearized estimators[12] as implemented in survey procedures for statistical software (e.g., SAS, SUDAAN, Stata). These software packages must be used because they permit estimation of sampling variances for multistage stratified sampling designs. They also account for unequal weighting and for sample clustering and stratification.

The final weight files also include PSU and strata variables which support the analysis of clustered survey data and accurate variance estimation. As in previous cycles, a variable for "variance strata," was added which may differ from the design strata, to ensure that all variance strata had at least two PSUs.[13]

Tables 4.4–4.7 present weighted estimates and estimated standard errors for key outcome measures using the 2019 NYTS data. Sample SAS and SUDAAN code is provided in Exhibit 4.1.

[11] The design effect due to unequal weighting may be expressed in terms of the cv of the weight as DEFF= 1 + cv**2.

[12] Skinner CJ, Holt D, and Smith TMF, Analysis of Complex Surveys, John Wiley & Sons, New York, 1989, 50.

[13] Specifically, two strata (coded 113 and 114) were combined into one variance stratum (114) because the original stratum "113" had only one PSU when analyzed at both the middle and high school level.

Exhibit 4.1: Example SAS and SUDAAN Code for Generating Weighted Tobacco Product Use Estimates (ever use, current use) and Standard Errors*

SAS:

```
Proc Surveymeans Data=nyts2019 mean;
Var eelcigt ecigt ecigar eslt ehookah celcigt ccigt ccigar cslt chookah;
Class eelcigt ecigt ecigar eslt ehookah celcigt ccigt ccigar cslt chookah;
Stratum v_stratum2;
Cluster psu2;
Weight finwgt;
Domain SCHOOLTYPE SCHOOLTYPE*Sex SCHOOLTYPE*Race_S;
Title "NYTS 2019, Tobacco Product Use Estimates by School Type, by School Type and Sex Cross-Classified,
and by School Type and Race/Ethnicity Cross-Classified";
run;
```

SUDAAN:

```
Proc Descript Data=nyts2019 Filetype= SAS Design=WR;
Var eelcigt ecigt ecigar eslt ehookah celcigt ccigt ccigar cslt chookah;
Catlevel 1 1 1 1 1 1 1 1 1 1;
Nest v_stratum2 PSU2 / Missunit;
Weight finwgt;
Subgroup SCHOOLTYPE Sex Race_S;
Levels 2 2 3;
Tables SCHOOLTYPE  SCHOOLTYPE*Sex SCHOOLTYPE*Race_S;
Title "NYTS 2019, Tobacco Product Use Estimates by School Type, by School Type and Sex Cross-Classified,
and by School Type and Race Cross-Classified";
Print Percent Sepercent / Style=NCHS;
run;
```

*Example SAS and SUDAAN code will generate estimates of ever use and current (past 30-day use) of e-cigarettes, cigarettes, cigars, smokeless tobacco products (chewing tobacco, snuff, or dip), and hookah tobacco. This is not an exhaustive list of all tobacco products assessed in the NYTS

Table 4.4 Current (past 30-day) Use Estimates for Selected Tobacco Products for High School Students[14]

Product	Overall %(SE)	Female %(SE)	Male %(SE)	White %(SE)	Black %(SE)	Hispanic %(SE)
Electronic cigarettes	27.47% (1.10%)	27.36% (1.20%)	27.63% (1.32%)	32.45% (1.34%)	17.69% (1.71%)	23.18% (1.35%)
Cigars, little cigars, or cigarillos	7.65% (0.55%)	6.18% (0.54%)	9.00% (0.72%)	7.60% (0.77%)	12.27% (1.16%)	6.17% (0.64%)
Cigarettes	5.78% (0.69%)	4.06% (0.58%)	7.32% (0.92%)	7.09% (0.96%)	3.94% (0.76%)	3.79% (0.53%)
Smokeless tobacco (chewing tobacco, snuff, or dip)	4.09% (0.60%)	1.13% (0.29%)	6.74% (0.94%)	5.70% (0.94%)	1.66% (0.56%)	1.86% (0.29%)
Hookah or waterpipe	3.38% (0.36%)	3.19% (0.39%)	3.55% (0.48%)	2.46% (0.36%)	6.42% (0.98%)	4.04% (0.62%)
Roll-your-own cigarettes	2.33% (0.31%)	1.92% (0.26%)	2.73% (0.46%)	2.53% (0.46%)	2.43% (0.48%)	1.94% (0.32%)
Snus	1.66% (0.24%)	0.77% (0.17%)	2.48% (0.37%)	2.20% (0.35%)	0.64% (0.31%)	0.98% (0.22%)
Pipe tobacco	1.08% (0.18%)	0.58% (0.15%)	1.54% (0.30%)	1.25% (0.31%)	0.98% (0.28%)	0.72% (0.15%)
Dissolvable tobacco products	0.47% (0.09%)	0.30% (0.12%)	0.62% (0.15%)	0.50% (0.13%)	0.04% (0.04%)	0.53% (0.18%)
Bidis	0.38% (0.06%)	0.21% (0.05%)	0.53% (0.11%)	0.31% (0.09%)	0.25% (0.11%)	0.51% (0.13%)

Note: In the dataset, variables associated with current use of each tobacco product are as follows: electronic cigarettes (celcigt); cigars, little cigars, or cigarillos (ccigar); cigarettes (ccigt); smokeless tobacco (cslt); hookah or waterpipe (chookah); roll-your-own cigarettes (crollcigts); snus (csnus); pipe tobacco (cpipe); dissolvable tobacco products (cdissolv); and bidis (cbidis).

[14] The estimates in tables 4.4–4.7 use the variable SCHOOLTYPE, which is coded as 1 (Middle School) if QN3 ranges from 1 to 3, and 2 (High School) if QN3 ranges from 4 – 7. Students who are missing QN3 are excluded from these tables.

Table 4.5 Current Use Estimates for Selected Tobacco Products for Middle School Students[15]

Product	Overall %(SE)	Female %(SE)	Male %(SE)	White %(SE)	Black %(SE)	Hispanic %(SE)
Electronic cigarettes	10.53% (0.62%)	10.77% (0.76%)	10.24% (0.79%)	10.32% (0.80%)	8.59% (1.14%)	13.14% (1.05%)
Cigars, little cigars, or cigarillos	2.35% (0.27%)	2.00% (0.35%)	2.70% (0.33%)	1.75% (0.31%)	3.95% (0.82%)	3.08% (0.51%)
Cigarettes	2.30% (0.28%)	2.45% (0.40%)	2.08% (0.27%)	2.14% (0.41%)	2.03% (0.42%)	3.08% (0.54%)
Hookah or waterpipe	1.55% (0.22%)	1.75% (0.35%)	1.33% (0.18%)	1.11% (0.27%)	2.07% (0.56%)	2.42% (0.51%)
Smokeless tobacco (chewing tobacco, snuff, or dip)	1.47% (0.19%)	0.54% (0.14%)	2.31% (0.33%)	1.70% (0.32%)	0.91% (0.37%)	1.45% (0.29%)
Roll-your-own cigarettes	1.31% (0.17%)	1.11% (0.20%)	1.43% (0.21%)	0.74% (0.17%)	1.39% (0.40%)	2.60% (0.41%)
Snus	0.58% (0.10%)	0.22% (0.08%)	0.92% (0.18%)	0.57% (0.13%)	0.38% (0.19%)	0.83% (0.22%)
Pipe tobacco	0.49% (0.09%)	0.37% (0.13%)	0.60% (0.14%)	0.40% (0.11%)	0.39% (0.20%)	0.83% (0.26%)
Bidis	0.38% (0.07%)	0.28% (0.11%)	0.47% (0.11%)	0.30% (0.11%)	0.47% (0.20%)	0.60% (0.17%)
Dissolvable tobacco products	0.34% (0.07%)	0.14% (0.09%)	0.53% (0.12%)	0.21% (0.10%)	0.52% (0.22%)	0.60% (0.20%)

Note: In the dataset, variables associated with current use of each tobacco product are as follows: electronic cigarettes (celcigt); cigars, little cigars, or cigarillos (ccigar); cigarettes (ccigt); smokeless tobacco (cslt); hookah or waterpipe (chookah); roll-your-own cigarettes (crollcigts); snus (csnus); pipe tobacco (cpipe); dissolvable tobacco products (cdissolv); and bidis (cbidis).

[15] The estimates in tables 4.4–4.7 use the variable SCHOOLTYPE, which is coded as 1 (Middle School) if QN3 ranges from 1 to 3, and 2 (High School) if QN3 ranges from 4 – 7. Students who are missing QN3 are excluded from these tables.

Table 4.6 Ever Use Estimates for Selected Tobacco Products for High School Students[16]

Product	Overall %(SE)	Female %(SE)	Male %(SE)	White %(SE)	Black %(SE)	Hispanic %(SE)
Electronic cigarettes	46.95% (1.38%)	46.23% (1.42%)	47.73% (1.97%)	52.15% (1.39%)	33.81% (2.04%)	44.93% (1.92%)
Cigarettes	22.60% (1.70%)	19.18% (1.28%)	25.66% (2.64%)	25.89% (1.93%)	14.51% (1.84%)	21.08% (2.21%)
Cigars, little cigars, or cigarillos	20.75% (1.38%)	16.76% (0.97%)	24.45% (2.31%)	22.02% (1.64%)	24.55% (1.58%)	17.91% (1.92%)
Smokeless tobacco (chewing tobacco, snuff, or dip)	10.29% (1.26%)	4.39% (0.79%)	15.64% (1.83%)	14.15% (1.69%)	4.45% (0.96%)	5.21% (0.88%)
Hookah or waterpipe	9.90% (1.14%)	9.42% (0.91%)	10.38% (1.90%)	8.09% (1.18%)	14.81% (1.97%)	11.79% (1.56%)
Roll-your-own cigarettes	6.39% (1.07%)	4.57% (0.55%)	8.09% (1.86%)	7.33% (1.33%)	4.18% (0.79%)	5.40% (1.09%)
Snus	5.02% (0.74%)	2.92% (0.48%)	6.96% (1.15%)	6.28% (0.95%)	1.81% (0.52%)	4.03% (0.88%)
Pipe tobacco	3.84% (0.73%)	2.04% (0.25%)	5.50% (1.33%)	4.53% (0.92%)	2.20% (0.45%)	2.94% (0.68%)
Dissolvable tobacco products	1.61% (0.22%)	1.04% (0.18%)	2.15% (0.39%)	1.45% (0.23%)	1.19% (0.33%)	2.03% (0.57%)
Bidis	1.50% (0.33%)	0.82% (0.16%)	2.14% (0.62%)	1.43% (0.39%)	0.90% (0.28%)	1.79% (0.45%)

Note: In the dataset, variables associated with ever use of each tobacco product are as follows: electronic cigarettes (eelcigt); cigars, little cigars, or cigarillos (ecigar); cigarettes (ecigt); smokeless tobacco (eslt); hookah or waterpipe (ehookah); roll-your-own cigarettes (erollcigts); snus (esnus); pipe tobacco (epipe); dissolvable tobacco products (edissolv); and bidis (ebidis).

[16] The estimates in tables 4.4–4.7 use the variable SCHOOLTYPE, which is coded as 1 (Middle School) if QN3 ranges from 1 to 3, and 2 (High School) if QN3 ranges from 4 – 7. Students who are missing QN3 are excluded from these tables.

Table 4.7 Ever Use Estimates for Selected Tobacco Products for Middle School Students[17]

Product	Overall %(SE)	Female %(SE)	Male %(SE)	White %(SE)	Black %(SE)	Hispanic %(SE)
Electronic cigarettes	19.90% (0.81%)	19.87% (0.96%)	19.87% (1.06%)	19.26% (1.01%)	18.44% (1.60%)	23.92% (1.25%)
Cigarettes	8.37% (0.62%)	8.03% (0.77%)	8.66% (0.64%)	8.18% (0.79%)	8.39% (1.17%)	9.18% (0.89%)
Cigars, little cigars, or cigarillos	6.29% (0.59%)	5.53% (0.72%)	6.99% (0.60%)	5.15% (0.54%)	9.63% (1.74%)	7.70% (0.76%)
Smokeless tobacco (chewing tobacco, snuff, or dip)	3.83% (0.47%)	2.13% (0.41%)	5.43% (0.67%)	4.89% (0.73%)	1.94% (0.54%)	3.18% (0.52%)
Hookah or waterpipe	3.54% (0.38%)	3.77% (0.46%)	3.29% (0.41%)	2.66% (0.39%)	4.17% (0.73%)	4.90% (0.70%)
Roll-your-own cigarettes	3.08% (0.33%)	3.03% (0.44%)	3.06% (0.32%)	2.52% (0.38%)	2.71% (0.56%)	4.81% (0.68%)
Snus	1.56% (0.19%)	0.81% (0.15%)	2.26% (0.30%)	1.66% (0.24%)	0.85% (0.25%)	2.01% (0.42%)
Pipe tobacco	1.55% (0.16%)	1.39% (0.20%)	1.69% (0.24%)	1.41% (0.25%)	1.98% (0.40%)	1.89% (0.32%)
Dissolvable tobacco products	1.09% (0.16%)	0.82% (0.17%)	1.36% (0.24%)	0.75% (0.19%)	1.35% (0.44%)	1.77% (0.34%)
Bidis	1.08% (0.15%)	1.03% (0.23%)	1.10% (0.17%)	0.86% (0.18%)	1.33% (0.36%)	1.68% (0.36%)

Note: In the dataset, variables associated with ever use of each tobacco product are as follows: electronic cigarettes (eelcigt); cigars, little cigars, or cigarillos (ecigar); cigarettes (ecigt); smokeless tobacco (eslt); hookah or waterpipe (ehookah); roll-your-own cigarettes (erollcigts); snus (esnus); pipe tobacco (epipe); dissolvable tobacco products (edissolv); and bidis (ebidis).

[17] The estimates in tables 4.4–4.7 use the variable SCHOOLTYPE, which is coded as 1 (Middle School) if QN3 ranges from 1 to 3, and 2 (High School) if QN3 ranges from 4 – 7. Students who are missing QN3 are excluded from these tables.

APPENDIX A. QUESTIONNAIRE

Questionnaire only included in PDF version of this document.

APPENDIX B. STUDENT WEIGHT DETAIL

Students were selected from schools via the selection of intact class sections as described in Section 2.3. The student sampling weight was computed based on a ratio of enrolling to responding students described in Section 4.1.1. The purpose of this section is to show that the resulting student weight is equivalent to computing a student weight as the inverse of the selection probability—as are the other stage sampling weights—followed by two adjustments, one for nonresponse and another poststratifying to known enrollment totals.

For the purposes of clarity, subscripts denoting the sampling stages and weight class are omitted. The unsubscripted quantities presented are assumed to be within weight class *c*, as defined in Section 4.1.1.

The probability of selection of a class when there are C_{jklm} classes at grade j in school k, PSU_i, stratum m is just $1/C_{jklm}$ or $2/C_{jklm,}$ depending on whether 1 or 2 classes are taken in the school. All students in a selected class were chosen so the probability of selection of a student is the same as the class, as well as constant across students within a student weighting class. The initial selection probability is taken to be the inverse of this sampling probability.

A simplified notation, letting K represent the number of sampled class sections, would look like:

$$W = \frac{C}{K}$$

Nonresponse Adjustment

The nonresponse adjustment inflates the weight of the responding students to equal that of the sampled students. The adjustment was calculated as the sum of the weights for sampled students to the sum of the weights for responding students,

$$F_{\text{NR}} = \frac{\sum_{\text{Selected}} \text{W}}{\sum_{\text{Responding}} \text{W}} = \frac{n}{R}$$

where *n* represents the number of sampled students and *R* represents the number of responding students in the student weight class. Note that the equation simplifies to a ratio that does not involve *W*, as *W* is constant within the class.

Enrollment Ratio Adjustment

Next, the nonresponse adjusted student weights are ratio-adjusted to conform to known school enrollment totals for each grade and sex. The adjustment F_{ps} is computed as

$$F_{\text{ps}} = \frac{N}{\sum W'} = \frac{N}{R * W'}$$

where N is the number of enrolled students in the weight class, and

$$W' = W * F_{NR}$$

The fully adjusted student weight is computed as:

$$W'' = W' * F_{PS}$$

The simplified equation is as follows:

$$\begin{aligned} W'' &= W' * F_{PS} \\ &= W' * \frac{N}{R * W'} \\ &= \frac{N}{R} \end{aligned}$$

APPENDIX C. COMMON CORE OF DATA RACE/ETHNICITY DEFINITIONS

Non-Hispanic American Indian/Alaska Native—A person having origins in any of the original peoples of North and South America (including Central America) and who maintains cultural identification through tribal affiliation or community recognition.

Non-Hispanic Asian/Pacific Islander—A person having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, or the Pacific Islands. This area includes, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, Thailand, Vietnam, Guam, the Philippine Islands, Samoa, and other Pacific Islands.

Non-Hispanic Black—A person having origins in any of the black racial groups of Africa; African American.

Hispanic—A person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race.

Non-Hispanic White—A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.