METHODOLOGY REPORT OF THE 2020 NATIONAL YOUTH TOBACCO SURVEY

Recommended Citation

Office on Smoking and Health. 2020 National Youth Tobacco Survey: Methodology Report. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2020.

June 2020

For questions about this report, please email Sean Hu at fik4@cdc.gov

Prepared for Centers for Disease Control and Prevention

Prepared by ICF, Rockville, Maryland

Centers for Disease Control and Prevention

Office on Smoking and Health

Atlanta, GA

June 2020

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CHAPTER 1—NYTS SAMPLING DESIGN

1.1 OVERVIEW OF THE NATIONAL YOUTH TOBACCO SURVEY (NYTS)

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] Tobacco-related indicators included in the NYTS are: tobacco use (e-cigarettes, cigarettes, cigars, smokeless tobacco, hookahs, roll-your-own cigarettes, pipes, snus, dissolvable tobacco, bidis, and heated tobacco products); exposure to secondhand 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. Estimates based on 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 (USDHHS, 2010): TU-2, TU-3, TU-7, TU-11, TU-18 and TU-19. Similarly, future cycles of NYTS will provide measures and data for Healthy People 2030 objectives (USDHHS, 2020): TU-3, TU4, TU5, TU-6, and TU7.

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) collaborated to administer the NYTS.

1.2 OVERVIEW OF THE 2020 NYTS METHODOLOGY

The 2020 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 began using electronic data collection methods starting in 2019. The 2020 cycle again was conducted electronically. 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

[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.

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 was 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 initiated on January 16, 2020 and was expected to extend until May 15, 2020. However, data collection was ended early on March 16, 2020 due to widespread school closures as a result of the COVID-19 pandemic. The final sample consisted of 361 schools, of which 180 participated prior to school closures, yielding a school participation rate of 49.9%. A total of 14,531 student questionnaires were completed out of a sample of 16,634 students, yielding a student participation rate of 87.4%. The overall participation rate, defined as the product of the school-level and student-level participation rates, was 43.6%.

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. Appendix A describes the evaluation undertaken to determine the feasibility of weighting the 2020 NYTS given the overall participation rate was lower than historic levels. The evaluation showed that the sample of 14,531 participating students from 180 schools was representative in terms of small potential bias and variances. The sample then was weighted with the procedures described in this report.

The remainder of this report provides detailed information on the methodology used in the 2020 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. 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	320 SSUs (school) selections: 240 large schools (2 per PSU), 50 medium schools and 30 small schools
3	Classes/students			2 classes per grade in half of large schools ;1 class per grade otherwise

As described in Section 1.2, the first stage of sampling selected Primary Sampling Units (PSUs) within each stratum for a total of 100 sample PSUs. At the second sampling stage, 240 large schools, or SSUs, were selected from the sample PSUs. Two large schools were selected per sample PSU, one per level (middle or high). An additional large school for each level was selected in a subsample of 20 PSUs. An additional 50 medium SSUs and 30 small SSUs were selected from subsample PSUs, for a total of 320 sample SSUs (320 = 240 + 50 + 30). 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.

Depending on the average design effects, target subgroup sample sizes were between 1,200 and 1,700. The NYTS design has experienced lower design effects with less oversampling over the last few cycles (due to proportional allocation and enrollment size measures). Compared to previous cycles, the NYTS sampling design has had both lower effects on unequal weighting and smaller clustering effects. These factors lead to lower design effects, particularly for subgroups. Smaller design effects have, in turn, led to smaller variances and improved precision.

An appropriate sample size can enable generation of estimates with the required precision by grade as well as by sex and school level. Therefore, the precision requirements generally focused on racial/ethnic subgroups within school level. The targets of n=850 students per minority group by school level (1,700 total per group) correspond to prevalence estimates within +/- 5% for confidence intervals at 95% confidence for all key racial/ethnic subgroups when broken down by school level.

Sample sizes for Hispanics, a subgroup that has steadily increased in representation, meet even the more conservative targets. Sample sizes for blacks, which bordered on but did not reach the original targets in 2020 when broken down by school level, still lead to precise subgroup estimates. These conservative targets reflected expected design effects that were larger than those observed for the NYTS.

These are evidenced in Tables 4-4 to 4-7 in Chapter 4, which show that for all key racial/ethnic subgroups, prevalence estimates were within +/- 5% for confidence intervals at 95% confidence (i.e., standard errors were less than 2.5%), as in the original design requirements. Standard errors were less than 2.5% for all estimates for Hispanic and black students at the middle school and high school level with one marginal exception.[3]

2.2 Sampling Frame

As in previous cycles, the 2020 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 MDR Inc. (Market Data Retrieval 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

[3] The marginal exception was for the ever use prevalence of electronic cigarettes for Hispanic high-school students where the standard error reached 2.54%.

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 NYTS.[4] Including schools sourced from the two NCES files resulted in a coverage increase among all public and non-public high schools of 6.6%. 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 excluded non-eligible schools by category to remove schools such as Department of Defense schools, vocational schools, and adult education schools. This resulted in the exclusion of 3.8% of schools (2.8% of public schools and 8.0% of private schools) and 1.1% of students. Lastly, schools were removed that had fewer than 40 students enrolled across eligible grades, resulting in the exclusion of 20.6% of schools (13.3% public and 42.8% private) which were eligible after the other exclusions. This exclusion of schools with fewer than 40 students led to the exclusion of only 1.06% 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 attending 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.

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 1,258 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, 240 large schools, or SSUs, were selected from the sample PSUs. Additionally, as described in Section 2.1, we selected 30 small schools and 50 medium schools, resulting in a total of 320 sample SSUs (320 = 240 + 50 + 30).
- 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

[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

from course schedules provided by each school so that all eligible students had only a single chance of selection.

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. We selected two classes per grade in large schools and one class per grade in the remaining schools. 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.

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 2.8 discusses the actual sample sizes attained in the survey. The NYTS sample size calculations were based on the following assumptions:

- The main structure of the sampling design was 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 40 large, 50 medium and 30 small schools from subsample PSUs.

Across 15 previous cycles of the NYTS that had concluded at the time of the 2020 NYTS design, school participation had averaged 82.9%. Student participation had averaged 89.7%. The combined response rate (student x school) averaged 74.3%. Historical participation rates at both school and student levels guided the sampling design and sample sizes. In calculating the sample sizes for the 2020 NYTS, we made our approach more robust by assuming a conservative combined rate (student x school) of 63.8%, substantially lower than the historical overall response rate. These numbers are closer to the more recent experience at both levels. Table 2.2 presents a detailed derivation of the sample sizes *planned* for the 2020 NYTS based on these assumptions.

Table 2.2 Planned Sample Sizes for the 2020 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 63.75% Response Rate
100	Large HS	120	Double classes: 60	8	25	12,000	7,650
			Single classes: 60	4	25	6,000	3,825
	Large MS	120	Double classes: 60	6	25	9,000	5,738
			Single classes:60	3	25	4,500	2,869
	Large Total	**240**				**31,500**	**20,081**
25 (sub-sample)	Medium HS	25	30	4	25	2,500	1,594
	Medium MS	25	30	3	25	1,875	1,195
	Medium Total	**50**				**4,375**	**2,789**
15 (sub-sample)	Small HS	15	20	4	25	1,500	956
	Small MS	15	20	3	25	1,125	717
	Small Total	**30**				**2,625**	**1,673**
	Overall Total	**320**				**38,500**	**24,544**

One-hundred PSUs were selected, with two large SSUs (“full” schools) selected from each PSU and one additional large SSU per level selected from 20 subsampled PSUs for a total of 240 large SSUs. The estimated sample yield from these large schools was 31,500 students before school and student non-response, leading to an expected total 20,081 participating students in large schools after accounting for non-response.

Additionally, 50 medium SSUs from a subsample of 25 PSUs were selected, yielding an expected sample size of 4,375 students. Finally, to provide adequate coverage of students in small schools (those with an enrollment of less than 28 students in any grade) 30 small SSUs from a subsample of 15 PSUs were selected. The expected yield was 2,625 students from small schools. In total, the number of participating students in large, medium, and small schools was 24,544.

For the 2020 NYTS, within each school, one class was selected from each grade to participate in the survey except in a portion of large schools where we implemented double class selection for half of large schools (randomly selected) to ensure sufficient student yields. Note that the set of the latter schools defined for double class sampling is necessarily a subset of the large schools that can support such double class sampling.

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 recombining 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 an SSU. Linked schools were treated as single schools during sampling. For example, a school containing 6th grade but not 7th and 8th grades can be linked with another school with the latter grades at the middle school level. At the high school level, a school that contains only 9th but not the other high school grades can be linked with another containing the latter grades.

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 non-Hispanic 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 were also 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 2020 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

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	2,207,124	8
		2	BU2	1,545,060	5
		3	BU3	455,124	2
		4	BU4	528,242	2
	Non-urban	1	BR1	2,638,754	9
		2	BR2	1,390,599	5
		3	BR3	984,474	4
		4	BR4	496,585	2
Hispanic	Urban	1	HU1	3,393,790	11
		2	HU2	2,569,896	9
		3	HU3	2,507,231	8
		4	HU4	1,931,026	7
	Non-urban	1	HR1	5,092,395	16
		2	HR2	1,462,461	5
		3	HR3	1,001,750	4
		4	HR4	676,887	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 additional large schools (20 PSUs), small school (15 PSUs) and medium school (25 PSUs) sampling of two schools per level in each subsample PSU.

2.8 Sample Sizes Attained in the Survey

The 2020 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 the 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 variable whereby all respondents are categorized into a single race/ethnic group. The sample led to 4,355 Hispanic students and 1,602 black students using the single-race variable.

Table 2.5a Subgroup Sample Sizes: Number of Participating Students

What is your sex?				
Q2	**Frequency**	**Percent**	**Cumulative Frequency**	**Cumulative Percent**
Displayed, not answered[5]	39	0.27	39	0.27
Male	7153	49.23	7192	49.49
Female	7339	50.51	14531	100.00

Table 2.5b Subgroup Sample Sizes: Number of Participating Students

What grade are you in?				
Q3	**Frequency**	**Percent**	**Cumulative Frequency**	**Cumulative Percent**
Displayed, not answered[5]	16	0.11	16	0.11
6th	2352	16.19	2368	16.30
7th	2354	16.20	4722	32.50
8th	2336	16.08	7058	48.57
9th	1966	13.53	9024	62.10
10th	1882	12.95	10906	75.05
11th	1799	12.38	12705	87.43
12th	1806	12.43	14511	99.86
Ungraded or other grade	20	0.14	14531	100.00

Table 2.5c Subgroup Sample Sizes: Number of Participating Students

RECODE: Race/Eth - mult grp				
RACE_M	**Frequency**	**Percent**	**Cumulative Frequency**	**Cumulative Percent**
<Missing>	365	2.51	365	2.51
NH-White	6521	44.88	6886	47.39
NH-Black	1529	10.52	8415	57.91
Hispanic	4355	29.97	12770	87.88
NH-Asian	821	5.65	13591	93.53
NH-AI/AN	204	1.40	13795	94.93
NH_NHOPI	54	0.37	13849	95.31
Multiple Races	682	4.69	14531	100.00

Note: This variable is named *race_m* (respondents could select more than one race) in the public use data set. The race/ethnicity 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). Please see the detailed definitions of race/ethnicity at Appendix D.

Table 2.5d Subgroup Sample Sizes: Number of Participating Students

RECODE: Race/Eth - no mult grp				
RACE_S	**Frequency**	**Percent**	**Cumulative Frequency**	**Cumulative Percent**
<Missing>	365	2.51	365	2.51
NH-White	7071	48.66	7436	51.17
NH-Black	1602	11.02	9038	62.20
Hispanic	4355	29.97	13393	92.17
NH-Asian	879	6.05	14272	98.22
NH-AI/AN	205	1.41	14477	99.63
NH-NHOPI	54	0.37	14531	100.00

Note: This variable is named *race_s* (all respondents are ultimately categorized into a single race/ethnic group, including those who selected more than one race) in the public use data set. The race/ethnicity 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). Please see the detailed definitions of race/ethnicity at Appendix D.

2.9 Sample Validation

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 2019-2020 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 2019-2020 school principal
- School street address used for overnight deliveries, with city name and ZIP code
- Grade levels served during 2019-2020 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 2020 survey instrument included 117 questions. The 2020 NYTS represented the second cycle the study was conducted using electronic data collection methods rather than the paper-and-pencil (PAPI) method used previously. 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 Samsung Tab A tablet. 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 9 classes used the Web-based survey for their initial administration due to scheduling preferences by the school to administer all classes during a common class period or conflicts that prevented a class from participating on the same day as other selected classes in the same school.

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. LOI for tablet-based administration ranged from 19 seconds to 80 mins 15 seconds, with an average of 14 mins 4 seconds. For Web-based administration, LOI ranged from 33 seconds to 79 mins 34 seconds, with an average of 15 mins 41 seconds. After exclusion of outliers[6], the average survey completion time for tablet and Web was about 14 mins 7 seconds.

The first five questions on the survey collected student demographic information, and the rest measured a comprehensive set of tobacco-related topics (Appendix B). 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 second-hand smoke; harm perceptions; exposure to tobacco product warnings; and tobacco use prevention school curricula. At the

[6] The average completion time was calculated after dropping outliers with survey duration lengths greater than 90 minutes (n=16).

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 to this description and the images as needed as they answered related questions. The 2020 NYTS was the first cycle to include a sexual orientation question.

Historically, 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 2020 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 for the 2019 NYTS, the Security Assessment and Authorization (SA&A) approval and Enterprise Performance Life Cycle (EPLC) review remained valid for the 2020 NYTS cycle. 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 January 13-17, 2020.

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

Schools in 34 states were selected to participate in the 2020 NYTS. Recruitment began in September 2019 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 was first obtained by 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 January 16, 2020, in coordination with a comprehensive data collector training, and continued through March 16, 2020 when widespread school closures due to the COVID-19 pandemic interrupted fielding. 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 with 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 (i.e., 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 or advisory periods were used as the frame for class selection.

3.6 Web-Based Data Collection Management Application

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 participation rates were recorded by the survey administrators into the DCMA described in Section 3.6. 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 Participation Rates

Participation rates for the NYTS were calculated at the school and student levels.

3.8.1 School-level Participation Rates

At the school level, 361 schools were selected across 254 districts in 34 states. During sample validation, 29 schools were deemed to be ineligible and were replaced.

In total, 180 schools (49.9%) participated in the study. A total of 74 schools were scheduled for data collection after March 16, 2020 but were not completed due to widespread school closures related to the COVID-19 pandemic. An additional 54 schools were still in recruitment and a final disposition was not obtained. The remaining 53 schools were considered refusals. Of refusals, 33 of them were due to their district refusing to grant access to their schools to discuss participation and 20 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 Participation Rates

Initial student-level participation 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 participation rate for the 2020 NYTS was 87%. Overall, 16,634 eligible students from the 180 participating schools were invited to participate in the survey, and 14,531 did so. Of note, data collection for the 2020 NYTS was truncated due to school closures associated with COVID-19; data collection ended on March 16, 2020. Table 3.1 below shows the number of eligible students, participants, and participation rates for the NYTS.

Table 3.1 Overall NYTS 2020 Student Participation Rate

	# Eligible	# Completed	Participation %
NYTS Participating Students	16,634	14,531	87.4%

The 2020 NYTS survey attained an actual school participation rate of 49.9% and a student participation rate of 87.4%. The overall participation rate, the product of the school-level and student-level participation rates, was 43.6%.

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 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-required classifications. Data "missingness" was categorized into one of four types: as a legitimate skip based on programmed logic (.S), as item-level refusal if a question was presented to a student on-screen but not answered (.N), as not answered because the student was never shown a question on screen (e.g., partial complete) (.Z), or as recoded to missing due to edit checks (.E). Missingness is distinguished in the data set as follows:

- .E – Missing due to edit check
- .S – Legitimate skip
- .N – Displayed, not answered (item-level refusal)
- .Z – Not displayed (partial complete)

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

CDC followed a deliberate process in deciding to weight the 2020 NYTS data despite the challenges presented by the truncated fielding window due to widespread school closures following the spread of the COVID-19 virus. Appendix A briefly describes the deliberative process as well as its results and conclusions to proceed with the weighting.

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

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

This chapter 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. This chapter closes with a description of 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 those large schools belonging to the 20 subsampled PSUs, the partial school weight was:

$$W^{LS}{}_{klm} = 2\left(\frac{MOS_{.lm}}{MOS_{klm}}\right) = \frac{1}{P^{LS}{}_{klm}}$$

For small schools, the partial school weight was:

$$W^{SS}{}_{klm} = (100/15)\left(\frac{MOS_{.lm}}{MOS_{klm}}\right) = \frac{1}{P^{SS}{}_{klm}}$$

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

$$W^{MS}{}_{klm} = (100/25)\left(\frac{MOS_{.lm}}{MOS_{klm}}\right) = \frac{1}{P^{MS}{}_{klm}}$$

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 2020 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 *2020 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 Step. 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 2020 cycle, school type, proportion of students under poverty line and urban status were found to be predictive on nonresponse. Nonresponse adjustment cells were created using school level (high vs middle), school type (public vs non-public), proportion of students below poverty line (above median vs below median) and urban status (city vs non-city).

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 divided by school level and proportion of students below poverty line; public schools were divided by school level, proportion of students below poverty line and urban status. We defined two poverty groups in each category by looking at the median of the school-level variable "proportion of students below the poverty line" (schools above or below the median of this variable).

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, Non-public, proportion of students below poverty is below median	188,964.37	3	608,771.86	7	42.857	3.222
High School, Non-public, proportion of students below poverty is above median	30,638.94	1	447,183.35	5	20.000	14.595
High School, public, proportion of students below poverty is below median, city	570,372.19	5	982,263.79	10	50.000	1.722

Weighting Class	Weight Sum Over Participants	Responding School Count	Weight Sum over all Sample	Sample School Count	Response Rate (%)	Adjustment Factor
High School, public, proportion of students below poverty is below median, non-city	3,613,229.58	30	8,509,251.98	71	42.254	2.355
High School, public, proportion of students below poverty is above median, city	980,355.27	9	3,000,505.79	32	28.125	3.061
High School, public, proportion of students below poverty is above median, non-city	3,060,009.25	31	3,905,323.39	41	75.610	1.276
Middle School, non-public, proportion of students below poverty is below median	102,541.31	2	611,631.48	11	18.182	5.965
Middle School, non-public, proportion of students below poverty is above median	187,216.45	4	659,747.18	11	36.364	3.524
Middle School, public, proportion of students below poverty is below median, city	173,725.19	2	907,141.50	10	20.000	5.222

Weighting Class	Weight Sum Over Participants	Responding School Count	Weight Sum over all Sample	Sample School Count	Response Rate (%)	Adjustment Factor
Middle School, public, proportion of students below poverty is below median, non-city	3,827,577.43	42	7,198,826.59	82	51.220	1.881
Middle School, public, proportion of students below poverty is above median, city	1,608,422.32	16	2,471,971.75	28	57.143	1.537
Middle School, public, proportion of students below poverty is above median, non-city	2,549,048.73	35	4,099,327.69	53	66.038	1.608
	16892101.02	**180**	**33401946.35**	**361**		

* 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 four variables used in non-response adjustment cells were school level (middle vs high school), school type (public vs non-public), proportion of students below poverty line (above median vs below median) and urban status (city vs non-city).

4.3 Post-stratification and Trimming

The final steps in the weighting process include trimming and post-stratification. 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 post-stratification, or raking, procedures described next.

Post-stratification 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 2017-18 CCD and the 2017-18 PSS, were 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).[7] 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 post-stratum cell. Post-stratification variables, also shown in the two tables, are a) school type by grade and sex, and b) census region by grade and race/ethnicity. These dimensions reflect the iterations used in the raking procedures.

[7] 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	1110	1,947,924.89
Public	6	Female	1154	1,856,189.11
Public	7	Male	1143	1,920,121.91
Public	7	Female	1082	1,827,816.09
Public	8	Male	1109	1,912,066.38
Public	8	Female	1088	1,823,161.62
Public	9	Male	895	2,002,535.13
Public	9	Female	941	1,879,501.87
Public	10	Male	868	1,893,367.40
Public	10	Female	916	1,810,372.60
Public	11	Male	813	1,783,595.77
Public	11	Female	889	1,738,184.23
Public	12	Male	832	1717515.72
Public	12	Female	875	1,690,406.28
Private	6	Combined	96	254,851.00
Private	7	Combined	135	252,753.00
Private	8	Combined	145	254,516.00
Private	9	Combined	130	254,889.00
Private	10	Combined	105	250,742.00
Private	11	Combined	98	249,096.00
Private	12	Combined	107	244,201.00

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

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

Census Region	Grade	Race/Ethnicity	Number of Records	Weight Sum = Control Total
Northeast	6	Non-Hispanic Other	300	415,523.32
Northeast	6	Non-Hispanic Black	25	86,745.53
Northeast	6	Hispanic	84	133,417.15
Northeast	7	Non-Hispanic Other	278	418,712.68
Northeast	7	Non-Hispanic Black	29	85,586.22
Northeast	7	Hispanic	115	128,800.10
Northeast	8	Non-Hispanic Other	311	429,840.68
Northeast	8	Non-Hispanic Black	27	84,693.89
Northeast	8	Hispanic	122	124,588.44
Northeast	9	Non-Hispanic Other	207	429,764.98
Northeast	9	Non-Hispanic Black	12	91,586.17
Northeast	9	Hispanic	74	129,617.85
Northeast	10	Non-Hispanic Other	191	421,659.41
Northeast	10	Non-Hispanic Black	13	86,719.70
Northeast	10	Hispanic	71	121,348.89
Northeast	11	Non-Hispanic Other	220	420,914.72
Northeast	11	Non-Hispanic Black	20	79,853.63
Northeast	11	Hispanic	91	107,284.65
Northeast	12	Non-Hispanic Other	218	422,603.90
Northeast	12	Non-Hispanic Black	16	77,933.10
Northeast	12	Hispanic	92	99,937.00
Midwest	6	Non-Hispanic Other	282	617,855.97
Midwest	6	Non-Hispanic Black	57	116,982.51
Midwest	6	Hispanic	76	112,706.51
Midwest	7	Non-Hispanic Other	247	617,522.21
Midwest	7	Non-Hispanic Black	44	111,331.97
Midwest	7	Hispanic	96	109,222.82
Midwest	8	Non-Hispanic Other	252	626,369.66
Midwest	8	Non-Hispanic Black	33	111,017.39
Midwest	8	Hispanic	103	107,145.94
Midwest	9	Non-Hispanic Other	298	638,225.42
Midwest	9	Non-Hispanic Black	32	118,931.71
Midwest	9	Hispanic	95	109,560.87
Midwest	10	Non-Hispanic Other	328	622,736.06
Midwest	10	Non-Hispanic Black	33	112,062.43
Midwest	10	Hispanic	110	103,957.51
Midwest	11	Non-Hispanic Other	308	609,640.87
Midwest	11	Non-Hispanic Black	30	104,628.70
Midwest	11	Hispanic	65	96,923.43
Midwest	12	Non-Hispanic Other	295	610,408.17
Midwest	12	Non-Hispanic Black	22	101,900.04
Midwest	12	Hispanic	84	89,502.78
South	6	Non-Hispanic Other	395	792,578.51
South	6	Non-Hispanic Black	243	363,665.63
South	6	Hispanic	258	423,494.86
South	7	Non-Hispanic Other	447	790,881.27
South	7	Non-Hispanic Black	270	351,680.50
South	7	Hispanic	339	409,341.22

Census Region	Grade	Race/Ethnicity	Number of Records	Weight Sum = Control Total
South	8	Non-Hispanic Other	447	792,573.59
South	8	Non-Hispanic Black	286	344,856.86
South	8	Hispanic	298	399,009.55
South	9	Non-Hispanic Other	391	825,891.15
South	9	Non-Hispanic Black	176	377,787.74
South	9	Hispanic	265	426,616.12
South	10	Non-Hispanic Other	346	793,577.60
South	10	Non-Hispanic Black	122	349,946.57
South	10	Hispanic	255	390,866.83
South	11	Non-Hispanic Other	315	766,118.94
South	11	Non-Hispanic Black	148	324,368.04
South	11	Hispanic	241	355,490.02
South	12	Non-Hispanic Other	330	738,315.45
South	12	Non-Hispanic Black	116	307,965.35
South	12	Hispanic	235	315,158.20
West	6	Non-Hispanic Other	378	508,970.09
West	6	Non-Hispanic Black	22	48,124.99
West	6	Hispanic	240	438,899.92
West	7	Non-Hispanic Other	272	505,670.20
West	7	Non-Hispanic Black	27	47,309.12
West	7	Hispanic	196	424,632.68
West	8	Non-Hispanic Other	231	509,287.52
West	8	Non-Hispanic Black	24	47,017.07
West	8	Hispanic	208	413,343.41
West	9	Non-Hispanic Other	244	517,076.59
West	9	Non-Hispanic Black	17	48,771.84
West	9	Hispanic	155	423,095.57
West	10	Non-Hispanic Other	240	500,098.97
West	10	Non-Hispanic Black	22	47,541.52
West	10	Hispanic	158	403,966.51
West	11	Non-Hispanic Other	219	487,857.86
West	11	Non-Hispanic Black	15	44,757.57
West	11	Hispanic	128	373,037.57
West	12	Non-Hispanic Other	237	485,680.96
West	12	Non-Hispanic Black	15	45,316.44
West	12	Hispanic	154	357,401.60

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.

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=88.55% implies that the design-effect (DEFF) component due to unequal weighing effects is 1.78.[8]

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

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[9] as implemented in SAS survey procedures. 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.[10]

Tables 4.4–4.7 present weighted estimates and estimated standard errors for key outcome measures using the 2020 NYTS data. Sample SAS code is provided in Exhibit 4.1.

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

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=nyts2020 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 2020, 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=nyts2020 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 2020, 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[11]

Product	Overall %(SE) N = 7453	Female %(SE) N = 3849	Male %(SE) N = 3594	White %(SE) N = 4037	Black %(SE) N = 670	Hispanic %(SE) N = 2255
Electronic cigarettes	19.58% (1.28%)	18.74% (1.43%)	20.42% (1.40%)	23.18% (1.34%)	9.10% (1.36%)	18.94% (2.09%)
Cigars, little cigars, or cigarillos	5.04% (0.53%)	4.68% (0.61%)	5.43% (0.65%)	4.16% (0.57%)	9.24% (1.27%)	5.63% (1.09%)
Cigarettes	4.62% (0.60%)	3.89% (0.57%)	5.37% (0.79%)	5.29% (0.71%)	2.84% (0.68%)	4.56% (0.85%)
Hookah or waterpipe	2.72% (0.34%)	2.86% (0.45%)	2.55% (0.35%)	1.75% (0.25%)	3.88% (0.87%)	4.41% (1.01%)
Smokeless tobacco (chewing tobacco, snuff, or dip)	2.67% (0.41%)	0.78% (0.15%)	4.51% (0.73%)	3.66% (0.58%)	0.75% (0.41%)	1.75% (0.43%)
Roll-your-own cigarettes	1.44% (0.21%)	1.46% (0.27%)	1.43% (0.29%)	0.97% (0.19%)	1.49% (0.53%)	2.45% (0.59%)
Snus	0.99% (0.18%)	0.54% (0.16%)	1.40% (0.31%)	1.33% (0.30%)	0.27% (0.23%)	0.74% (0.16%)
Pipe tobacco	0.72% (0.15%)	0.43% (0.11%)	1.02% (0.26%)	0.90% (0.22%)	0.30% (0.19%)	0.71% (0.25%)
Dissolvable tobacco products	0.33% (0.10%)	0.22% (0.11%)	0.43% (0.15%)	0.46% (0.17%)	0.32% (0.33%)	0.12% (0.06%)
Bidis	0.23% (0.06%)	0.14% (0.06%)	0.33% (0.11%)	0.22% (0.08%)	0.08% (0.08%)	0.40% (0.17%)

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).

[11] 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[12]

Product	Overall %(SE) N = 7042	Female %(SE) N = 3481	Male %(SE) N = 3539	White %(SE) N = 3025	Black %(SE) N = 930	Hispanic %(SE) N = 2087
Electronic cigarettes	4.65% (0.62%)	4.77% (0.80%)	4.54% (0.62%)	4.26% (0.57%)	2.61% (0.68%)	7.10% (1.12%)
Cigarettes	1.62% (0.26%)	1.99% (0.37%)	1.28% (0.22%)	1.27% (0.34%)	2.09% (0.53%)	2.20% (0.45%)
Cigars, little cigars, or cigarillos	1.50% (0.20%)	1.60% (0.29%)	1.42% (0.22%)	0.85% (0.24%)	3.12% (0.55%)	1.85% (0.42%)
Hookah or waterpipe	1.34% (0.23%)	1.51% (0.34%)	1.19% (0.20%)	0.70% (0.15%)	1.70% (0.55%)	2.41% (0.65%)
Smokeless tobacco (chewing tobacco, snuff, or dip)	0.93% (0.15%)	0.61% (0.16%)	1.24% (0.25%)	1.06% (0.25%)	0.99% (0.34%)	0.76% (0.25%)
Roll-your-own cigarettes	0.86% (0.17%)	0.91% (0.21%)	0.80% (0.23%)	0.39% (0.13%)	1.08% (0.24%)	1.26% (0.37%)
Pipe tobacco	0.40% (0.10%)	0.38% (0.14%)	0.42% (0.14%)	0.26% (0.12%)	0.56% (0.34%)	0.44% (0.17%)
Snus	0.36% (0.08%)	0.42% (0.15%)	0.31% (0.10%)	0.38% (0.14%)	0.64% (0.26%)	0.24% (0.09%)
Bidis	0.17% (0.05%)	0.17% (0.07%)	0.18% (0.08%)	0.08% (0.04%)	0.50% (0.34%)	0.13% (0.07%)
Dissolvable tobacco products	0.15% (0.04%)	0.08% (0.04%)	0.22% (0.08%)	0.07% (0.03%)	0.46% (0.30%)	0.17% (0.09%)

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).

[12] 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[13]

Product	Overall %(SE) N = 7453	Female %(SE) N = 3849	Male %(SE) N = 3594	White %(SE) N = 4037	Black %(SE) N = 670	Hispanic %(SE) N = 2255
Electronic cigarettes	39.38% (1.50%)	38.31% (1.71%)	40.46% (1.75%)	44.02% (1.27%)	22.18% (2.46%)	40.74% (2.54%)
Cigarettes	16.66% (1.29%)	15.60% (1.28%)	17.68% (1.61%)	18.41% (1.67%)	10.38% (1.70%)	17.27% (1.75%)
Cigars, little cigars, or cigarillos	14.20% (1.12%)	11.42% (1.20%)	16.95% (1.41%)	14.93% (1.33%)	15.65% (1.72%)	13.78% (1.99%)
Smokeless tobacco (chewing tobacco, snuff, or dip)	7.70% (1.07%)	3.18% (0.56%)	12.18% (1.63%)	10.74% (1.52%)	3.02% (0.80%)	4.07% (0.73%)
Hookah or waterpipe	7.60% (0.74%)	7.67% (0.93%)	7.49% (0.73%)	6.24% (0.55%)	9.51% (1.91%)	10.02% (1.83%)
Roll-your-own cigarettes	3.86% (0.41%)	3.64% (0.51%)	4.10% (0.46%)	3.78% (0.44%)	2.60% (0.65%)	4.68% (0.97%)
Snus	3.51% (0.50%)	2.53% (0.38%)	4.47% (0.72%)	4.67% (0.75%)	0.72% (0.42%)	2.73% (0.45%)
Pipe tobacco	2.71% (0.41%)	1.67% (0.30%)	3.75% (0.68%)	3.55% (0.66%)	0.82% (0.39%)	2.12% (0.36%)
Dissolvable tobacco products	1.48% (0.28%)	1.11% (0.27%)	1.86% (0.39%)	1.85% (0.38%)	0.91% (0.49%)	1.06% (0.25%)
Bidis	1.03% (0.17%)	0.72% (0.16%)	1.34% (0.27%)	1.03% (0.24%)	0.31% (0.17%)	1.32% (0.34%)

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).

[13] 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[14]

Product	Overall %(SE) N = 7042	Female %(SE) N = 3481	Male %(SE) N = 3539	White %(SE) N = 3025	Black %(SE) N = 930	Hispanic %(SE) N = 2087
Electronic cigarettes	10.79% (0.90%)	10.15% (1.00%)	11.39% (1.00%)	10.58% (0.93%)	7.54% (1.07%)	15.09% (1.49%)
Cigarettes	6.00% (0.66%)	6.19% (0.76%)	5.77% (0.67%)	5.45% (0.74%)	8.02% (1.02%)	6.72% (0.86%)
Cigars, little cigars, or cigarillos	3.50% (0.37%)	3.17% (0.48%)	3.81% (0.41%)	2.70% (0.30%)	7.38% (1.05%)	3.45% (0.67%)
Smokeless tobacco (chewing tobacco, snuff, or dip)	2.95% (0.35%)	2.04% (0.29%)	3.84% (0.56%)	3.52% (0.60%)	3.30% (0.67%)	2.15% (0.41%)
Hookah or waterpipe	2.87% (0.36%)	2.91% (0.47%)	2.82% (0.36%)	1.72% (0.30%)	4.24% (0.87%)	4.48% (0.86%)
Roll-your-own cigarettes	2.10% (0.27%)	2.15% (0.27%)	1.99% (0.38%)	1.39% (0.27%)	3.43% (0.67%)	2.75% (0.41%)
Pipe tobacco	1.25% (0.18%)	1.33% (0.23%)	1.17% (0.24%)	0.95% (0.19%)	1.10% (0.42%)	1.82% (0.34%)
Snus	1.00% (0.17%)	0.87% (0.18%)	1.14% (0.28%)	1.19% (0.28%)	0.83% (0.33%)	1.04% (0.27%)
Bidis	0.85% (0.14%)	0.69% (0.14%)	1.00% (0.25%)	0.63% (0.19%)	1.52% (0.56%)	1.17% (0.31%)
Dissolvable tobacco products	0.81% (0.13%)	0.78% (0.18%)	0.84% (0.18%)	0.60% (0.16%)	1.06% (0.52%)	1.27% (0.25%)

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).

[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.

APPENDIX A. IMPLICATIONS OF COVID-19 CLOSURES FOR WEIGHTING THE 2020 NYTS DATA

This appendix discusses the checks performed to ensure that the 2020 NYTS survey data could be weighted after data collection was truncated due to widespread school closures as a result of the COVID-19 pandemic.

The first two steps checked that the sample was representative from the perspective of potential bias and that supports precise estimates for the key subgroups of interest. When the sample passes these initial checks, as shown below that the 2020 NYTS sample did, the weighting process itself provides additional checkpoints.

The inflection points provided in the weighting process begin with a thorough nonresponse analysis that supports weight adjustments designed to minimize any potential bias. The weighting process further adjusts the survey data to ensure the weighted distribution matches the population data along demographic, geographic and socio-economic characteristics.

Step 1: Is the participating school sample representative?

- Checks on the representation by region, school type, and level
- Checks on the representation of all design strata

We compared the distribution of the sample schools with the distribution of participating schools under the two definitions. The broader subset of 254 agreeing schools includes those 74 schools that were scheduled, but these were not included in the narrower subset of n=180 participating schools. We looked at the distributions by region (South, East, Midwest and West), by type (public and non-public), by level (middle school and high school) and by the 16 design strata.

Table A-1: Regional Distribution of Sample: Agreeing, and Participating Schools

Region	Sample Schools	Set of Agreeing Schools (n=254)	Final subset Participating Schools (n=180)
Midwest	21.33%	17.32%	20.00%
Northeast	15.24%	18.11%	17.78%
South	38.23%	37.80%	41.11%
West	25.21%	26.77%	21.11%

Table A-2: Distribution by School Type: Sample, Agreeing, and Participating Schools

Region	Sample Schools	Set of Agreeing Schools (n=254)	Final subset Participating Schools (n=180)
Non-public	9.42%	5.91%	5.56%
Public	90.58%	94.09%	94.44%

Table A-3: Distribution by School Level: Sample, Agreeing, and Participating Schools

Region	Sample Schools	Set of Agreeing Schools (n=254)	Final subset Participating Schools (n=180)
High School	45.98%	45.28%	43.89%
Middle School	54.02%	54.72%	56.11%

Table A-4: Distribution by Strata: Sample, Agreeing, and Participating Schools

Region	Sample Schools	Set of Agreeing Schools (n=254)	Final subset Participating Schools (n=180)
BR1	7.76%	9.45%	7.78%
BR2	3.88%	5.12%	7.22%
BR3	3.60%	3.54%	4.44%
BR4	2.22%	3.15%	4.44%
BU1	8.31%	8.66%	9.44%
BU2	4.16%	2.36%	3.33%
BU3	2.22%	1.57%	1.67%
BU4	1.11%	0.79%	0.00%
HR1	16.07%	16.93%	17.22%
HR2	4.71%	5.12%	5.00%
HR3	4.16%	5.51%	6.11%
HR4	3.32%	4.33%	3.33%
HHU1	11.63%	8.66%	8.33%
HU2	9.97%	8.27%	10.56%
HU3	8.59%	7.48%	6.11%
HU4	8.31%	9.06%	5.00%

The tables show that the distributions of the subsets of participating schools are generally similar to the original sample distributions.[15]

Additional non-response analyses were performed under Step 3 described below as part of the weighting process.

Step 2: Can precise estimates be computed?

Step 2 included the three interrelated actions discussed below, which depend on sample sizes and design effects (DEFFs) to gauge the expected precision of subgroup estimates. Unlike the empirical tests described in Step 4 below, which involve weighted estimates following the

[15] One of the sixteen design strata had no participating schools. This does not present any statistical or analytical challenges as the substrata can be collapsed for the analyses.

computation of the weights, the three actions in Step 2 can take place before weighting to signal that weights can and should be computed.

- Check key subgroup sample sizes (n's) that suggest precise subgroup estimates (e.g., for minority students)
- Estimate expected precision for subgroup estimates and overall, using projected n's and DEFFs
- Estimate expected precision for subgroup estimates, and overall, using unweighted data

We projected the expected numbers of black and Hispanic students in the participating schools. using the percentages of minority students in each school available in the sampling frame data, and then validated them using the survey data. As discussed in Section 2.1, the numbers exceed historical targets but not the most recent targets of 1,700 per subgroup (falling short for the subgroup of blacks by school level); nevertheless, the precision is still better than the required levels. As shown in Tables 4-4 to 4-7 in the full report, standard errors for subgroup estimates are all less than 2.5% so that 95% confidence intervals are all within +/- 5 percentage points. That is true even for subgroups defined by racial/ethnic groups within school level groupings.

These numbers showed that precise subgroup estimates by race/ethnicity and by sex for the 2020 NYTS weighted data could confidently be computed, as shown in Chapter 4.

Step 3: Compute survey weights

As a typical prelude to the weighting process, additional analyses were conducted to compare non-participating schools and participating schools. These analyses were even more critical for the 2020 NYTS in light of the expanded pool of non-participating schools. Specifically, these analyses were central to the need for a) demonstrating that the bias potential is minimal as non-participating schools did not differ substantially from participating schools, and b) ensuring that non-response weight adjustments minimized whatever potential bias that might result from non-response.

Most of these comparisons were based on school characteristics such as location (region, urban vs non-urban), school type, and school size. Some of these comparisons include school-level student characteristics such as the percentage of black and Hispanic students and socio-economic variables.

Significant differences between participating and non-participating schools were observed in bivariate analyses for the following school characteristics:

- School type (Public, Non-public)
- NCES Locale (City, Suburb, Town, Rural)
- Region (Northeast, Midwest, South, West)
- Enrollment Shift
- Percent of students' college bound
- Proportion of Students below Poverty Line

Multivariate logistic regression models then identified a subset of these variables as significant: -

- School Type
- NCES Locale (two categories, City versus non-City); and
- Poverty Level

These were the variables entered in the logistic regression model (i,e., those highlighted as significant in the bivariate analyses) that had significant coefficients and odds ratios ($p < 0.05$).

To minimize bias potential, weighting classes for school non-response weight adjustments were based on these characteristics. As described in Chapter 4, nonresponse adjustment cells were created using school level (high vs middle), school type (public vs non-public), proportion of students below poverty line (above median vs below median) and urban status (city vs non-city).

Step 4: Compute weighted estimates and compare with previous cycles

We computed weighted estimates for key NYTS measures as summarized in Tables 4-3 to 4-7 in the full report. As stated above, standard errors for subgroup estimates are all less than 2.5% so that 95% confidence intervals are all within +/- 5 percentage points.

We also compared the weighted estimates and variances to similar estimates computed for the 2019 NYTS overall and by key subgroups defined by school level, gender and race/ethnicity. While weighted estimates were generally similar, notable declines in prevalence were observed for key measures of cigarette and electronic cigarette use. Sample sizes were large enough, and variances small enough, to detect this remarkable decline in nearly all measures, but particularly evident for those products with relatively higher prevalence in 2019 (e.g., electronic cigarettes). This trend was also consistent across all subgroups.

On the other hand, variances and standard errors were generally similar in magnitude despite the smaller sample sizes, overall and for key subgroups, due in part to the smaller magnitudes of prevalence rates overall.

APPENDIX B. QUESTIONNAIRE

Questionnaire only included in PDF version of this document.

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,

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

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

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

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 D. 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.