# METHODOLOGY REPORT OF THE 2018 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 Survey (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., bidis, cigarettes, cigars, tobacco pipes, smokeless tobacco, snus, dissolvable tobacco products, hookahs, and electronic cigarettes); exposure to secondhand smoke; smoking cessation; minors' ability to purchase or obtain tobacco products; and, 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 (USDHHS, 2010): TU-2, TU-3, TU-7, TU-11, TU-18 and TU-19.

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 2018 NYTS Methodology

The 2018 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. Participating students completed the survey via pencil and paper using a self-administered, scannable questionnaire booklet.

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.

[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.

The final sample consisted of 310 schools, of which 238 participated, yielding a school participation rate of 76.8%. A total of 20,189 student questionnaires were completed out of a sample of 22,729 students, yielding a student participation rate of 88.8%. The overall participation rate, defined as the product of the school-level and student-level participation rates, was 68.2%.

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 2018 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 considerably according to differences in subpopulation sizes.

The target population 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. Primary sampling units (PSUs) were stratified by racial/ethnic status and urban versus rural. 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 "rural." 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 | 270 SSUs (school) selections: 200 large schools (2 per PSU), 30 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 |

The sample was designed to provide target sample sizes in the key analytic subgroups of interest. More specifically, the study was designed to produce national estimates at a 95% confidence level with a margin of error of 5% 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). With the average design effects attained in the NYTS, the requirements translated to subgroup sample sizes of 1,200 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 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 2018 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 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.[3] 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 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 3.86% of schools (2.85% public and 7.94% private) and 0.64% of students. Next, schools were removed that had fewer than 40 students in the eligible grades, resulting in the exclusion of 14.36% of schools (8.31% public and 38.93% private) and 1.35% of students.

## 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.

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

The sampling stages may be summarized as follows:

- Selection of PSUs—One hundred 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, 30 medium schools from 15 subsample PSUs (one school for each level). This resulted in a total of 270 SSUs (270 = 200+40+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.
- 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.

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, medium SSUs contained between 28 and 55 per grade, and large SSUs contained at least 56 students at each grade level. 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 the simulation study to ensure that the required numbers of minority students were achieved per school level.

The sampling approach utilized 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 were then 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 30 medium and 40 small schools from subsample PSUs.

Across 11 previous cycles of the NYTS that had concluded at the time of the 2018 NYTS design, school participation had averaged 83.8% with a low of 72.5%. Student participation had averaged 90.0% with a low of 87.4%. The combined response rate (student x school) averaged 75.43% Historical participation 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 2018 NYTS based on these assumptions.

*Table 2.2 Planned Sample Sizes for the 2018 NYTS*

| PSU | Size | # of SSUs | Number of Schools Sampled | # of Classes per School | # of Students per Class | # of Sampled Students prior to Attrition | # of Participated Students Based on 72% Response Rate |
|---|---|---|---|---|---|---|---|
| **100** | Large HS | 100 | Double classes: 50 | 8 | 25 | 10,000 | 7,200 |
| | | | Single classes: 50 | 4 | 25 | 5,000 | 3,600 |
| | Large MS | 100 | Double classes: 50 | 6 | 25 | 7,500 | 5,400 |
| | | | Single classes: 50 | 3 | 25 | 3,750 | 2,700 |
| | **Large Total** | **200** | | | | **26,250** | **18,900** |
| **15 (sub-sample)** | Medium HS | 15 | 15 | 4 | 25 | 1,500 | 1,080 |
| | Medium MS | 15 | 15 | 3 | 25 | 1,125 | 810 |
| | **Medium Total** | **30** | | | | **2,625** | **1,890** |
| **20 (sub-sample)** | Small HS | 20 | 20 | 4 | 20 | 1,600 | 1,152 |
| | Small MS | 20 | 20 | 3 | 20 | 1,200 | 864 |
| | **Small Total** | **40** | | | | **12,800** | **2,016** |
| | **Overall Total** | **270** | | | | **31,675** | **22,806** |

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 26,250 students before school and student non-response, leading to an expected total 18,900 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) 30 medium SSUs from a subsample of 15 PSUs, and 40 small SSUs from a subsample of 20 PSUs were selected. The expected yield was 1,890 from medium schools and 2,016 students from small schools. In total, the number of participating students was 22,806.

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 2018 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/rural 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, or "rural" (for simplicity).
- Hispanic urban and Hispanic rural 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 rural 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[4] 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 2018 NYTS.

*Table 2.3 Stratum Boundaries: Minority Percentage Cutoffs*

| Minority Concentration | Density Group | Bounds | |
|---|---|---|---|
| | | Urban | Rural |
| 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 2018 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.

[4] 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/Rural | Density Group Number | Stratum Code | Student Population | Number of Sample PSUs (Revised) |
|---|---|---|---|---|---|
| Non-Hispanic Black | Urban | 1 | BU1 | 2,227,951 | 8 |
| | | 2 | BU2 | 1,540,898 | 5 |
| | | 3 | BU3 | 471,727 | 2 |
| | | 4 | BU4 | 507,056 | 2 |
| | Non-urban | 1 | BR1 | 2,698,983 | 9 |
| | | 2 | BR2 | 1,308,136 | 5 |
| | | 3 | BR3 | 1,006,800 | 4 |
| | | 4 | BR4 | 485,551 | 2 |
| Hispanic | Urban | 1 | HU1 | 3,424,131 | 12 |
| | | 2 | HU2 | 2,477,544 | 8 |
| | | 3 | HU3 | 2,455,318 | 8 |
| | | 4 | HU4 | 1,912,601 | 7 |
| | Non-urban | 1 | HR1 | 5,036,843 | 16 |
| | | 2 | HR2 | 1,284,402 | 3 |
| | | 3 | HR3 | 988,655 | 3 |
| | | 4 | HR4 | 523,491 | 2 |

The sample was selected with probabilities proportional to size (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 (15 PSUs) sampling of two schools per level in each subsample PSU.

## 2.8 Sample Sizes Attained in the Survey

The 2018 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 post-stratification which includes complete data. By either measure, the sample led to more than 5,700 Hispanic students. It also led to 3,169 black students using the imputed variable and nearly 2,400 black students using the original variable.

*Table 2.5a Subgroup Sample Sizes: Number of Participating Students*

| What is your sex? | | | | |
|---|---|---|---|---|
| **Q2** | **Frequency** | **Percent** | **Cumulative Frequency** | **Cumulative Percent** |
| **Female** | 9920 | 49.63 | 9920 | 49.63 |
| **Male** | 10069 | 50.37 | 19989 | 100.00 |
| **Frequency Missing = 200** | | | | |

*Table 2.5b Subgroup Sample Sizes: Number of Participating Students*

| What grade are you in? | | | | |
|---|---|---|---|---|
| **Q3** | **Frequency** | **Percent** | **Cumulative Frequency** | **Cumulative Percent** |
| **6th** | 2903 | 14.47 | 2903 | 14.47 |
| **7th** | 3140 | 15.65 | 6043 | 30.12 |
| **8th** | 3012 | 15.01 | 9055 | 45.14 |
| **9th** | 2935 | 14.63 | 11990 | 59.76 |
| **10th** | 2664 | 13.28 | 14654 | 73.04 |
| **11th** | 2824 | 14.08 | 17478 | 87.12 |
| **12th** | 2568 | 12.8 | 20046 | 99.92 |
| **Ungraded or other grade** | 16 | 0.08 | 20062 | 100 |
| **Frequency Missing = 127** | | | | |

*Table 2.5c Subgroup Sample Sizes: Number of Participating Students*

| RECODE: Race/Eth - mult grp | | | | |
|---|---|---|---|---|
| **RACE_M** | **Frequency** | **Percent** | **Cumulative Frequency** | **Cumulative Percent** |
| **NH-White** | 8941 | 46.42 | 8941 | 46.42 |
| **NH-Black** | 2414 | 12.53 | 11355 | 58.96 |
| **Hispanic** | 5761 | 29.91 | 17116 | 88.87 |
| **NH-Asian** | 726 | 3.77 | 17842 | 92.64 |
| **NH-AI/AN** | 304 | 1.58 | 18146 | 94.22 |
| **NH-NHOPI** | 100 | 0.52 | 18246 | 94.74 |
| **Multiple Races** | 1014 | 5.26 | 19260 | 100.00 |
| **Frequency Missing = 929** | | | | |

*Table 2.5d Subgroup Sample Sizes: Number of Participating Students*

| Race Categories for Post-stratification | | | | |
|---|---|---|---|---|
| **Imputed Race/Ethnicity** | **Frequency** | **Percent** | **Cumulative Frequency** | **Cumulative Percent** |
| **Asian/Native Hawaiian/Other PI** | 1005 | 4.98 | 1005 | 4.98 |
| **Black or African American** | 3169 | 15.70 | 4174 | 20.67 |
| **Hispanic/Latino** | 5910 | 29.27 | 10084 | 49.95 |
| **American Indian/Alaska Native** | 484 | 2.40 | 10568 | 52.35 |
| **White** | 9621 | 47.65 | 20189 | 100.00 |

**Note:** 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).

## 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 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 2018 survey instrument included 88 questions. The first five questions 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; 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.

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 2018 NYTS: the Office of Management and Budget (OMB), ICF's Institutional Review Board (IRB) and CDC's

## 3.3 Recruitment Procedures

The schools selected to participate in the 2018 NYTS were in 33 different states. Recruitment began in October 2017 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; 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 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. 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.

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.

## 3.4 Data Receipt, Processing, and Scanning

The completed surveys were shipped directly from the field to the contractor's headquarters for processing and scanning. Shipments were immediately logged in as received and checked for completeness (i.e., data from all expected schools and classes were accounted for). The status of each school's received data was logged into the case management system described in Section 3.5. Survey booklets were counted and discrepancies with the reported number of completed booklets reconciled. Booklets were also individually reviewed, page by page, to make sure bubbles were sufficiently filled in; stray pencil marks, comments, or illustrations that could interfere with scanning were erased; defaced booklets or those completed in something other than a No. 2 pencil were transcribed; and that at least one question had been answered. This process was repeated for each class within a school. As make-up surveys were received back from teachers, the process was again repeated and all accompanying documentation for that school was updated. Survey booklets received as part of the make-up process were manually edited to capture an artificial date value of "January 00" in order to allow for separate analyses later among the subset of records completed as make-ups rather than part of the initial survey administration. All data were subsequently scanned using an optical scanner.

## 3.5 Participation Rates

Participation 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 participation rates equal to or greater than 60%.[5]

### 3.5.1 School-level Participation Rates

At the school level, 310 schools were selected across 212 districts in 33 states. During sample validation, 29 schools were deemed to be ineligible and were replaced

In total, 238 schools (76.8%) participated in the study. The remaining 72 schools were considered refusals. Of refusals, 52 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.

### 3.5.2 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 reviewed, further refinements were made to: 1) revise the number of eligible students based on available documentation, 2) correct mathematical errors, 3) review counts of completed surveys, and 4) incorporate make-ups as they

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

were received from schools from students and classes that did not participate on the initial day of survey administration.

After visual editing, incorporating make-ups, and receiving missing classes, the final student participation rate for the 2018 NYTS was 88.8%. Overall, 22,729 eligible students were invited to participate in the survey, and 20,189 did so. Table 3.1 below shows the number of eligible students, participants, and participation rates for the NYTS.

*Table 3.1 Overall NYTS 2018 Student Participation Rate*

| | # Eligible | # Completed | Participation % |
|---|---|---|---|
| NYTS Participating Students | 22,729 | 20,189 | 88.8% |

When the student participation rate is combined with the school participation rate, the combined overall study participation rate was 68.2%, thus considered sufficient for weighting purposes.

The 2018 NYTS survey attained an actual school participation rate of 76.8% and a student participation rate of 88.8%. The overall participation rate, the product of the school-level and student-level participation rates, was 68.2%.

## 3.6 Data Management

Scanned data were converted from separate school-specific ASCII files to a single national SAS dataset. Because the NYTS is administered via a paper-and-pencil booklet, there is no restriction for the participant (e.g., providing two or more responses to a single response question) that prevents inconsistencies in the dataset. Therefore, 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.

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
- Post-stratification 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:

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

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 poststratified 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 2017 NYTS cycle, the school nonresponse adjustment methods were refined to further minimize nonresponse bias potential. As opposed to the previous method, which created adjustment cells based on sampling strata, the new method defined nonresponse adjustment cells in a more tailored and systematic approach stemming from the non-response analysis. These analyses are detailed in the *2018 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 2018 cycle, NCES locale, poverty level and proportion of students in English language learning (ELL) classes were found to be predictive on nonresponse. Nonresponse adjustment cells were created using school type (public vs private), NCES locale and poverty level. Because of the small number of sample non-public schools, they were included as their own category in the nonresponse adjustment cells.

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 NCES Locale (4 categories) and by poverty level.

*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 |
|---|---|---|---|---|---|---|
| Non-public Schools | 1,954,035.05 | 26 | 2,464,465.08 | 35 | 74.286 | 1.261 |
| Public Schools, Not Poor, City | 120,231.75 | 2 | 1,115,113.64 | 11 | 18.182 | 9.275 |
| Public Schools, Poor*, City | 5,264,177.89 | 52 | 6,975,007.40 | 68 | 76.471 | 1.325 |
| Public Schools, Not Poor, Suburb | 3,824,189.26 | 35 | 6,678,452.89 | 59 | 59.322 | 1.746 |
| Public Schools, Poor, Suburb | 5,055,217.96 | 48 | 5,581,908.73 | 53 | 90.566 | 1.104 |
| Public Schools, Not Poor, Town | 1,414,109.53 | 9 | 1,715,253.77 | 13 | 69.231 | 1.213 |
| Public Schools, Poor, Town | 2,410,126.69 | 20 | 2,410,126.69 | 20 | 100.00 | 1.000 |
| Public Schools, Not Poor, Rural | 1,909,968.23 | 15 | 2,071,481.89 | 16 | 93.750 | 1.085 |
| Public Schools, Poor, Rural | 3,202,155.08 | 31 | 3,973,121.25 | 35 | 88.571 | 1.241 |
| | 25,154,211.43 | 238 | 32,984,931.32 | 310 | | |

* 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 two variables used in non-response adjustment cells are NCES Locale (4 categories) and a dichotomous poverty indicator. The poverty indicator for a school is based on a school-level variable, the proportion of student below the poverty. The indicator classifies as "poor" those above the median for this proportion, and as "non-poor" those at or below the 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).[6] 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 are also 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.

[6] 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 | Gender | Number of Records | Weight Sum = Control Total |
|---|---|---|---|---|
| Public | 6 | Male | 1218 | 1,887,823.87 |
| Public | 6 | Female | 1323 | 1,796,776.13 |
| Public | 7 | Male | 1313 | 1,918,137.18 |
| Public | 7 | Female | 1435 | 1,8266,32.82 |
| Public | 8 | Male | 1411 | 1,912,633.97 |
| Public | 8 | Female | 1250 | 1,828,214.03 |
| Public | 9 | Male | 1423 | 2,008,367.98 |
| Public | 9 | Female | 1371 | 1,884,892.02 |
| Public | 10 | Male | 1324 | 1,861,825.26 |
| Public | 10 | Female | 1231 | 1,789,842.74 |
| Public | 11 | Male | 1386 | 1,711,309.31 |
| Public | 11 | Female | 1349 | 1,678,618.69 |
| Public | 12 | Male | 1265 | 1,643,305.91 |
| Public | 12 | Female | 1175 | 1,628,871.09 |
| Private | 6 | Combined | 364 | 244,092.00 |
| Private | 7 | Combined | 410 | 241,805.00 |
| Private | 8 | Combined | 371 | 236,912.00 |
| Private | 9 | Combined | 169 | 232,776.00 |
| Private | 10 | Combined | 136 | 231,500.00 |
| Private | 11 | Combined | 124 | 226,218.00 |
| Private | 12 | Combined | 141 | 220,662.00 |

*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 | 99 | 39374.42 |
| Public | 6 | Non-Hispanic Asian and Pacific Islander | 106 | 197794.42 |
| Public | 6 | Non-Hispanic Black | 384 | 581340.65 |
| Public | 6 | Hispanic | 766 | 961282.04 |
| Public | 6 | Non-Hispanic White | 1186 | 1904808.47 |
| Public | 7 | Non-Hispanic Native American | 91 | 40001.74 |
| Public | 7 | Non-Hispanic Asian and Pacific Islander | 104 | 197430.31 |
| Public | 7 | Non-Hispanic Black | 454 | 593270.66 |
| Public | 7 | Hispanic | 886 | 964625.76 |
| Public | 7 | Non-Hispanic White | 1213 | 1949441.54 |
| Public | 8 | Non-Hispanic Native American | 67 | 40234.54 |
| Public | 8 | Non-Hispanic Asian and Pacific Islander | 148 | 200029.94 |
| Public | 8 | Non-Hispanic Black | 433 | 594425.34 |
| Public | 8 | Hispanic | 831 | 940420.61 |
| Public | 8 | Non-Hispanic White | 1182 | 1965737.57 |
| Public | 9 | Non-Hispanic Native American | 69 | 43149.08 |
| Public | 9 | Non-Hispanic Asian and Pacific Islander | 129 | 195315.11 |
| Public | 9 | Non-Hispanic Black | 432 | 651138.66 |
| Public | 9 | Hispanic | 779 | 978398.96 |
| Public | 9 | Non-Hispanic White | 1385 | 2025258.20 |
| Public | 10 | Non-Hispanic Native American | 51 | 39358.76 |
| Public | 10 | Non-Hispanic Asian and Pacific Islander | 119 | 194973.41 |
| Public | 10 | Non-Hispanic Black | 405 | 579675.39 |
| Public | 10 | Hispanic | 727 | 881161.65 |
| Public | 10 | Non-Hispanic White | 1253 | 1956498.80 |
| Public | 11 | Non-Hispanic Native American | 50 | 34874.72 |
| Public | 11 | Non-Hispanic Asian and Pacific Islander | 142 | 193666.84 |
| Public | 11 | Non-Hispanic Black | 434 | 513086.02 |
| Public | 11 | Hispanic | 795 | 781658.91 |
| Public | 11 | Non-Hispanic White | 1314 | 1866641.52 |
| Public | 12 | Non-Hispanic Native American | 27 | 33646.81 |
| Public | 12 | Non-Hispanic Asian and Pacific Islander | 91 | 190497.87 |
| Public | 12 | Non-Hispanic Black | 399 | 482280.82 |
| Public | 12 | Hispanic | 705 | 725853.28 |
| Public | 12 | Non-Hispanic White | 1218 | 1839898.23 |
| Private | 6 | Combined | 364 | 244092.00 |
| Private | 7 | Combined | 410 | 241805.00 |
| Private | 8 | Combined | 371 | 236912.00 |
| Private | 9 | Combined | 169 | 232776.00 |
| Private | 10 | Combined | 136 | 231500.00 |
| Private | 11 | Combined | 124 | 226218.00 |
| Private | 12 | Combined | 141 | 220662.00 |

For poststratification purposes, a method of imputing at random with equal probabilities has been applied when the race variable is missing. So, 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=74.3% implies that the design-effect (DEFF) component due to unequal weighing effects is 1.55.[7]

## 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[8] 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.[9]

Tables 4.4–4.7 present weighted estimates and estimated standard errors for key outcome measures using the 2018 NYTS data. Sample SAS code is provided in Exhibit 4.1.

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

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

9 Specifically, two strata (coded 113 and 114) were combined into one variance stratum (114) because the original stratum "113" had zero PSU when analyzed at the high school level.

*Exhibit 4.1: Example SAS and SUDAAN Code for Generating Weighted Estimates and Standard Errors*

**SAS:**

```
Proc Surveymeans Data=nyts2018 mean;
Var ebidis ecigar ecigt edissolv;
Class ebidis ecigar ecigt edissolv;
Stratum v_stratum2;
Cluster psu2;
Weight finwgt;
Domain HSMS HSMS*Sex HSMS*Race_S;
Title “NYTS 2018, 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=nyts2018 Filetype= SAS Design=WR;
Var ebidis ecigar ecigt edissolv;
Catlevel 1 1 1 1;
Nest v_stratum2 PSU2 / Missunit;
Weight finwgt;
Subgroup HSMS Sex Race_S;
Levels 2 2 3;
Tables HSMS HSMS*Sex HSMS*Race_S;
Title “NYTS 2018, 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;
```

*Table 4.4 Current Use Estimates[10] for Selected Tobacco Products for High School Students*

| Product: Variable (name) | Overall %(SE) | Female %(SE) | Male %(SE) | White %(SE) | Black %(SE) | Hispanic %(SE) |
|---|---|---|---|---|---|---|
| **CBIDIS (Bidis)** | 0.71% (0.08%) | 0.53% (0.12%) | 0.88% (0.14%) | 0.76% (0.13%) | 0.43% (0.18%) | 0.88% (0.20%) |
| **CCIGAR (Cigar)** | 7.73% (0.48%) | 6.11% (0.64%) | 9.14% (0.48%) | 7.85% (0.60%) | 9.16% (1.40%) | 7.69% (0.80%) |
| **CCIGT (Cigarette)** | 8.27% (0.56%) | 7.39% (0.67%) | 8.93% (0.65%) | 9.97% (0.77%) | 3.20% (0.57%) | 7.59% (0.75%) |
| **CDISSOLV (Dissolvable tobacco product)** | 0.76% (0.09%) | 0.54% (0.13%) | 0.93% (0.15%) | 0.84% (0.13%) | 0.31% (0.18%) | 0.93% (0.21%) |
| **CELCIGT (Electronic cigarette)** | 20.84% (1.02%) | 18.86% (1.11%) | 22.64% (1.06%) | 26.83% (1.08%) | 7.48% (1.17%) | 15.10% (1.07%) |
| **CHOOKAH (Hookah)** | 4.22% (0.36%) | 4.23% (0.52%) | 4.10% (0.35%) | 3.32% (0.37%) | 3.94% (0.72%) | 6.30% (0.76%) |
| **CPIPE (Pipe)** | 1.13% (0.14%) | 0.82% (0.16%) | 1.39% (0.18%) | 1.13% (0.18%) | 0.82% (0.38%) | 1.50% (0.26%) |
| **CROLLCIGTS (Roll-your-own cigarette)** | 2.81% (0.27%) | 2.29% (0.30%) | 3.26% (0.35%) | 2.70% (0.32%) | 2.46% (0.55%) | 3.78% (0.56%) |
| **CSLT (Smokeless tobacco)** | 4.51% (0.46%) | 1.28% (0.24%) | 7.55% (0.77%) | 6.06% (0.71%) | 1.18% (0.36%) | 2.67% (0.38%) |
| **CSNUS (Snus)** | 2.44% (0.22%) | 1.93% (0.25%) | 2.80% (0.33%) | 2.93% (0.32%) | 0.99% (0.30%) | 2.03% (0.33%) |

[10] The estimates in tables 4.4 – 4.7 use the variable HSMS not provided on the public use file. Similar subgroup estimates can be produced using the variable Q3 which is included in that data file

*Table 4.5 Current Use Estimates[11] for Selected Tobacco Products for Middle School Students*

| **Product: Variable (name)** | **Overall %(SE)** | **Female %(SE)** | **Male %(SE)** | **White %(SE)** | **Black %(SE)** | **Hispanic %(SE)** |
|---|---|---|---|---|---|---|
| CBIDIS **(Bidis)** | 0.30% (0.06%) | 0.37% (0.12%) | 0.24% (0.08%) | 0.31% (0.11%) | 0.00% (0.00%) | 0.52% (0.13%) |
| CCIGAR **(Cigar)** | 1.57% (0.20%) | 1.51% (0.24%) | 1.61% (0.25%) | 1.04% (0.20%) | 2.89% (0.65%) | 2.00% (0.34%) |
| CCIGT **(Cigarette)** | 1.68% (0.20%) | 1.36% (0.24%) | 1.98% (0.28%) | 1.57% (0.31%) | 1.32% (0.43%) | 2.16% (0.31%) |
| CDISSOLV **(Dissolvable tobacco product)** | 0.28% (0.06%) | 0.15% (0.06%) | 0.41% (0.12%) | 0.20% (0.07%) | 0.30% (0.18%) | 0.44% (0.15%) |
| CELCIGT **(Electronic cigarette)** | 4.84% (0.40%) | 4.70% (0.46%) | 4.98% (0.51%) | 4.80% (0.50%) | 3.02% (0.52%) | 6.49% (0.85%) |
| CHOOKAH **(Hookah)** | 1.11% (0.16%) | 0.86% (0.15%) | 1.35% (0.25%) | 0.75% (0.20%) | 1.26% (0.58%) | 1.96% (0.31%) |
| CPIPE **(Pipe)** | 0.35% (0.07%) | 0.39% (0.10%) | 0.33% (0.08%) | 0.26% (0.09%) | 0.29% (0.20%) | 0.67% (0.15%) |
| CROLLCIGTS **(Roll-your-own cigarette)** | 1.19% (0.16%) | 0.85% (0.14%) | 1.50% (0.25%) | 0.96% (0.23%) | 1.37% (0.35%) | 1.64% (0.32%) |
| CSLT **(Smokeless tobacco)** | 1.26% (0.19%) | 0.32% (0.09%) | 2.13% (0.35%) | 1.26% (0.26%) | 0.96% (0.41%) | 1.45% (0.26%) |
| CSNUS **(Snus)** | 0.53% (0.10%) | 0.54% (0.14%) | 0.54% (0.13%) | 0.56% (0.15%) | 0.00% (0.00%) | 0.89% (0.19%) |

[11] The estimates in tables 4.4–4.7 use the variable HSMS not provided on the public use file. Similar subgroup estimates can be produced using the variable Q3 which is available in that data file

*Table 4.6 Ever Use Estimates[12] for Selected Tobacco Products for High School Students*

| **Product: Variable (name)** | **Overall %(SE)** | **Female %(SE)** | **Male %(SE)** | **White %(SE)** | **Black %(SE)** | **Hispanic %(SE)** |
|---|---|---|---|---|---|---|
| EBIDIS **(Bidis)** | 1.89% (0.21%) | 1.74% (0.26%) | 2.00% (0.28%) | 2.23% (0.29%) | 0.92% (0.35%) | 2.10% (0.30%) |
| ECIGAR **(Cigar)** | 20.50% (0.84%) | 16.79% (1.10%) | 24.00% (0.88%) | 22.24% (1.07%) | 20.55% (2.49%) | 18.93% (1.10%) |
| ECIGT **(Cigarette)** | 24.36% (0.95%) | 22.55% (1.26%) | 26.03% (1.04%) | 26.61% (1.24%) | 16.60% (2.01%) | 24.73% (1.30%) |
| EDISSOLV **(Dissolvable tobacco product)** | 1.79% (0.18%) | 1.35% (0.19%) | 2.13% (0.29%) | 1.89% (0.21%) | 1.19% (0.31%) | 1.97% (0.32%) |
| EELCIGT **(Electronic cigarette)** | 36.64% (1.22%) | 34.87% (1.46%) | 38.32% (1.19%) | 43.54% (1.24%) | 18.44% (1.58%) | 32.33% (1.51%) |
| EHOOKAH **(Hookah)** | 11.16% (0.65%) | 11.28% (0.80%) | 10.98% (0.73%) | 10.15% (0.69%) | 9.26% (1.17%) | 14.96% (1.09%) |
| EPIPE **(Pipe)** | 3.40% (0.28%) | 2.87% (0.33%) | 3.79% (0.41%) | 3.71% (0.39%) | 1.44% (0.51%) | 4.38% (0.58%) |
| EROLLCIGTS **(Roll-your-own cigarette)** | 6.19% (0.47%) | 5.59% (0.54%) | 6.71% (0.56%) | 6.99% (0.60%) | 3.72% (0.57%) | 6.26% (0.73%) |
| ESLT **(Smokeless tobacco)** | 10.06% (0.74%) | 4.51% (0.46%) | 15.46% (1.16%) | 13.50% (1.10%) | 2.76% (0.54%) | 5.68% (0.66%) |
| ESNUS **(Snus)** | 5.98% (0.46%) | 4.53% (0.45%) | 7.40% (0.69%) | 7.61% (0.69%) | 1.22% (0.46%) | 5.42% (0.62%) |

[12] The estimates in tables 4.4–4.7 use the variable HSMS not provided on the public use file. Similar subgroup estimates can be produced using the variable Q3 which is available in that data file.

*Table 4.7 Ever Use Estimates[13] for Selected Tobacco Products for Middle School Students*

| Product: Variable (name) | Overall %(SE) | Female %(SE) | Male %(SE) | White %(SE) | Black %(SE) | Hispanic %(SE) |
|---|---|---|---|---|---|---|
| EBIDIS **(Bidis)** | 0.69% (0.10%) | 0.77% (0.16%) | 0.62% (0.15%) | 0.62% (0.17%) | 0.36% (0.19%) | 1.03% (0.20%) |
| ECIGAR **(Cigar)** | 5.19% (0.52%) | 4.25% (0.53%) | 6.07% (0.60%) | 3.77% (0.52%) | 9.87% (1.50%) | 6.38% (0.66%) |
| ECIGT **(Cigarette)** | 7.82% (0.59%) | 7.37% (0.73%) | 8.21% (0.64%) | 6.70% (0.78%) | 10.33% (1.33%) | 9.86% (0.74%) |
| EDISSOLV **(Dissolvable tobacco product)** | 0.73% (0.11%) | 0.54% (0.15%) | 0.92% (0.17%) | 0.63% (0.14%) | 0.52% (0.22%) | 1.05% (0.22%) |
| EELCIGT **(Electronic cigarette)** | 11.78% (0.64%) | 11.05% (0.79%) | 12.54% (0.71%) | 11.45% (0.89%) | 10.13% (0.88%) | 14.81% (1.26%) |
| EHOOKAH **(Hookah)** | 2.61% (0.31%) | 2.46% (0.34%) | 2.73% (0.39%) | 1.67% (0.29%) | 4.01% (0.82%) | 4.00% (0.64%) |
| EPIPE **(Pipe)** | 0.84% (0.13%) | 0.88% (0.21%) | 0.82% (0.18%) | 0.63% (0.16%) | 0.66% (0.37%) | 1.14% (0.25%) |
| EROLLCIGTS **(Roll-your-own cigarette)** | 2.43% (0.20%) | 2.09% (0.29%) | 2.67% (0.26%) | 1.85% (0.32%) | 2.71% (0.50%) | 3.45% (0.41%) |
| ESLT **(Smokeless tobacco)** | 3.11% (0.33%) | 1.27% (0.23%) | 4.88% (0.57%) | 3.95% (0.51%) | 1.38% (0.44%) | 2.44% (0.35%) |
| ESNUS **(Snus)** | 1.57% (0.21%) | 1.42% (0.22%) | 1.74% (0.29%) | 1.77% (0.35%) | 0.47% (0.23%) | 1.85% (0.32%) |

[13] The estimates in tables 4.4–4.7 use the variable HSMS not provided on the public use file. Similar subgroup estimates can be produced using the variable Q3, which is available in that data file.

## 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.

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