2015 National Youth Tobacco Survey

Methodology Report

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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 spring 2000, 2002, 2004, 2006, 2009, 2011, 2012, 2013, 2014 and 2015, 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 annually.

1.2 Overview of the 2015 NYTS Methodology

The 2015 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. Non-Hispanic black students were oversampled. 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 created 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.

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[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] MacDonald, G., Starr, G., Schooley, M., Yee, S. L., Klimowski. K., Turner, K. (2001). *Introduction to program evaluation for comprehensive tobacco control programs*. Atlanta, GA: US Department of Health and Human Services, CDC.

Participation in the NYTS was voluntary at both the school and student levels. At the student level, participation was anonymous. Schools used either passive or active permission forms at their discretion to fulfill requirements of the No Child Left Behind Act, whereby parents must be provided with a means to opt out of their child's participation.

The final sample consisted of 255 schools, of which 185 participated, yielding a school participation rate of 72.6%. A total of 17,711 student questionnaires were completed out of a sample of 20,259 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 63.4%.

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 2015 NYTS sample selection (Chapter 2), data collection (Chapter 3), and weighting of student response data (Chapter 4).

CHAPTER 2—NYTS SAMPLING METHODS

2.1 Overview

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 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). Additional estimates were also supported for subgroups defined by grade, by sex, and by race/ethnicity, each within school level domains; however, precision levels will vary considerably 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, 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 2015 NYTS is a continuation of the NYTS cycles that took place in 1999, 2000, 2002, 2004, 2006, 2009, 2011, 2012, 2013 and 2014. The NYTS employs a repeat cross-sectional design to develop national estimates of tobacco use behaviors and exposure to pro- and anti-tobacco influences among students enrolled in grades 6–12. The general sampling design framework used for the 2014 NYTS was also employed for the 2015 NYTS.

2.1.1 Oversampling of Racial/Ethnic Minorities

To facilitate accurate prevalence estimates among racial/ethnic minority groups, prior cycles of the NYTS have employed multiple strategies to increase the number of non-Hispanic black and Hispanic students included in the sample. These approaches have included over-sampling PSUs in high racial/ethnic minority strata, the use of a weighted measure of size (MOS), and double class selection in large schools that contain a sufficient proportion of minority students.

The design development process examines parameters such as thresholds for double class selection and PSU allocation to strata, to balance the dual goals of overall precision and minority group targets.

The sampling design balances increasing yields for minority students with overall precision as oversampling leads to larger variances for overall estimates. As described below, the only oversampling that remains in the more efficient design for the 2015 NYTS is double class sampling. This method has been shown to reduce design effects for survey estimates. The design effect, defined as the variance of actual survey estimates divided by the variance of a simple random sample of the same size, is a common useful measure of the precision of survey estimates.

A weighted measure of size (MOS) was previously used to increase the probability of selection of high racial/ethnic minority PSUs and schools using a Probability Proportional to Size (PPS) sampling design. The effectiveness of a weighted MOS in achieving oversampling is dependent upon the distributions of non-Hispanic black and Hispanic students in schools. The need for a weighted MOS is predicated on a relatively low prevalence of minority students in the population; however, this premise has become less tenable with the increase of nonwhite students in the population overall, and specifically, Hispanic students. The need for oversampling Hispanic students has been gradually reduced with the increasing numbers of Hispanics among the student population. As seen below, some degree of oversampling non-Hispanic black students remains in the sampling design.

In 1990, the contactor, ICF (formerly Macro International Inc.), conducted the first in a series of simulation studies to investigate the impact of various weighting functions on the numbers and percentages of racial/ethnic minority students reached in YRBS.[3] Sampling strategies based on this work were incorporated into the NYTS, and these simulations have been updated with each cycle of the NYTS to ensure that the minimum amount of weighting in the MOS is being used, while still achieving adequate representation of non-Hispanic black and Hispanic students. When the possibility of using an unweighted measure of enrollment size was investigated for the 2012 NYTS, results demonstrated that adequate representation of non-Hispanic black and Hispanic students would be achieved through the use of an unweighted MOS. Thus, starting with the 2013 NYTS and continuing for 2014 and 2015 NYTS, student enrollment was used as the unweighted MOS, leading to improvements in the statistical efficiency of the design.

The MOS used in the 2015 NYTS sampling design no longer oversampled schools with heavier minority concentrations directly. In addition, the allocation to strata was proportional so the second oversampling approach was also no longer in effect. Nevertheless, double class selection was still implemented in the 2015 NYTS sampling.

In previous NYTS cycles, schools with high racial/ethnic populations were subject to double class selection. More specifically, two classes per grade were selected in these schools, compared to one class per grade in other schools, to increase the number of racial/ethnic minority students sampled. In the 2015 NYTS, double class selection was used only in large schools that had greater than 3% non-Hispanic black student enrollment. The threshold was developed, and updated, to generate the necessary numbers of participating non-Hispanic black students to ensure estimation precision for this subgroup.

2.1.2 Frame Construction

The frame was constructed from separate sources obtained from the National Center for Education Statistics (NCES) and from a commercial vendor, Market Data Retrieval Inc. (MDR Inc.). The NCES files were the Common Core of Data (CCD) for public schools and Private School Survey (PSS) for private schools. In addition, the frame incorporated data from the MDR dataset.

The reason for moving to a frame built from multiple data sources was to increase the coverage of schools nationally. This dual-source frame build method was implemented for the 2014 NYTS survey for the first time[4], and the method was replicated for the 2015 NYTS. Including schools

[3] Errecart, M. T. (1990, October 5). *Issues in Sampling African-Americans and Hispanics in School-Based Surveys*. Atlanta, GA: Centers for Disease Control.

[4] Redesigning National School Surveys: Coverage and Stratification Improvement using Multiple Datasets. William

sourced from the two NCES files resulted in a coverage increase among all public and non-public high schools of 23%. There was a 15.5% increase of coverage among public schools and a 46% increase in coverage among non-public high schools.

2.1.3 Sampling Stages and Measure of Size

The three-stage cluster sample was stratified by racial/ethnic composition and urban versus rural status at the first (primary) stage. PSUs were defined as a county, a portion of a county, or a group of counties. PSUs were classified as "urban" if they are in one of the 54 largest metropolitan statistical areas (MSAs) in the U.S using 2012 American Community Survey (ACS) data from the US Census Bureau. Otherwise, they were classified as "nonurban." The 16 primary strata are defined in Exhibit 2-2. Additionally, implicit stratification was imposed by geography by sorting the PSU frame by State and by 5-digit ZIP Code (within State). Within each stratum, a PSU was randomly sampled without replacement at the first stage.

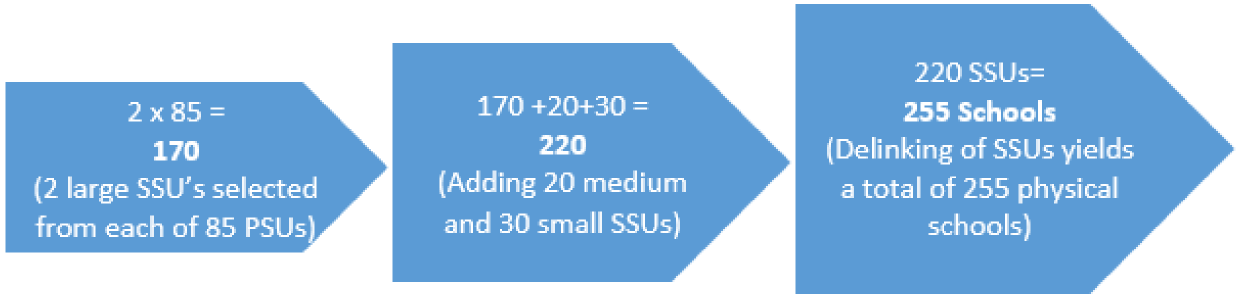
In subsequent sampling stages, a probabilistic selection of schools and students was made from the sample PSUs. It may be helpful to stress that unlike the 2014 NYTS, the 2015 NYTS is designed to balance the yields across grades. Therefore, the PSU subsampling is simplified to vary across school sizes but not between school level categories.

The sampling stages may be summarized as follows, with additional details provided in Section 2.2:

- *Selection of PSUs*: Eighty five 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 170 large schools or second-stage units (SSUs) were selected from the 85 sample PSUs. Two large schools were selected per sample PSU, one per level (middle or high), for a total of 170 large sample SSUs. An additional 20 medium SSUs and 30 small SSUs were selected from subsample PSUs, for a total of 220 sample SSUs (220= 170+30+20). Figure 2.1 shows the sample sizes for SSUs and the number of sampled schools. The PSU subsample was drawn as a simple random sample, 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 by default chosen for participation. Classes were selected from course schedules provided by each school that agreed to participate. Schedules were constructed such that all eligible students were represented one time only.

Robb, Kate Flint, Alice Roberts, Ronaldo Iachan - ICF International, FEDCASIC March 2014

FIGURE 2.1 PROCESS LEADING TO NUMBER OF SAMPLED SCHOOLS



Schools were stratified into large, medium, and small schools based on their ability to support two, one, or less than one class selection per grade. In large schools, an average of 1.46 classes were selected per grade by selecting two classes per grade in 46% of selected large schools and one class per grade in the remaining schools. The double class sampling took place in schools with non-Hispanic black enrollments over the established 3% threshold. Specifically, double class sampling took place by design in 78 of the 170 sample large schools, or 45.8% of these schools.

The sampling approach utilized PPS sampling methods. In PPS sampling, when the MOS is defined as the count of final-stage sampling units, and a fixed number of units are selected in the final stage, the result is an equal probability of selection for all members of the universe. For the NYTS, we approximate these conditions, and thus obtain a roughly self-weighting sample.

The MOS also was used to compute stratum sizes and PSU sizes. Assigning an aggregate measure of size to PSU, the sample allocates the PSU sample in proportion to the student population. Exhibit 2-1 presents a high-level summary of the key sampling design features that will be described in detail in the next sections.

EXHIBIT 2-1: KEY SAMPLING DESIGN FEATURES

	Sampling Units	Stratification	Measure of Size	Designed Sample Size	Actual Sample Size
1	Counties, portions of a county, or groups of counties	Urban vs. Nonurban (2 strata); Minority concentration (8 strata)	Aggregate school size in target grades	85 Counties, portions of a county, or groups of counties	85 Counties, portions of a county, or groups of counties
2	Schools	Small, medium and large; High school vs. middle school	Eligible enrollment	220 SSU (school) selections: 170 large schools, 20 medium schools and 30 small schools	220 SSUs; 255 physical schools; 185 participated
3	Classes / students			1 or 2 classes per grade (2 per grade in large, high-minority schools) 27,789 students sampled; 21,000 participants	20,259 students sampled; 17,711 students participating

2.2 Stratification and Linking

This section describes the following steps that are necessary for the selection of the first- and second-stage samples of PSUs and schools: organizing counties into Primary Sampling Units; linking schools into SSUs; and implementing the stratification and allocation methods at each of these stages.

2.2.1 Primary Sampling Unit (PSU)

Defining a PSU

In general, PSUs are geographic areas defined as counties or groupings of counties. In defining a PSU, several issues are considered:

1. Each PSU should be large enough to contain the requisite numbers of schools and students by grade, yet not so large as to be selected with near certainty.
2. Each PSU should be compact geographically so that field staff can go from school to school easily.
3. Recent data should be available to characterize each PSU.
4. Each PSU should contain at least four middle and five high schools.

Generally, counties were equivalent to PSUs with two exceptions:

1. Low population counties are combined to provide sufficient numbers of schools and students; and

2. Counties that are very large may be split to avoid becoming certainty or near-certainty PSUs.

Certainty PSUs are those whose size is large enough to ensure selection with probability one (1.0) with a PPS sampling design that selects larger PSUs with larger probabilities. As certainty PSUs lead to inefficiencies in the design, they are split so that the new smaller units are no longer selected with a probability of one. Near-certainty units also are split to build in a safety buffer in the PSU sizes. County population figures were aggregated from school enrollment data for the grades of interest.

The 2015 NYTS PSU definitions were based on the definitions developed in the coordinated 2013 YRBS-NYTS cycles, and also used in the 2014 NYTS cycle. The exact PSUs defined in the 2015 NYTS sampling frame were updated to ensure that all PSUs met the criteria above. The frame had 1,259 PSUs, 520 of which were comprised of one single county.

Stratification of PSUs

The PSUs were organized into 16 strata, based on urban/rural location (as defined above) and racial/ethnic minority enrollment of non-Hispanic blacks and Hispanics. In the traditional stratification used by the NYTS, the classification of PSUs into the two racial/ethnic minority strata, non-Hispanic black and Hispanic, is based on the predominant minority in the PSU. This classification is coupled with the density distribution of non-Hispanic blacks and Hispanics to subdivide each of the four primary strata into four substrata, indexed by 1-4 according to this density. The approach for computing stratum boundaries follows the cumulative square root of "f" method developed by Dalenius and Hodges.[5] The boundaries or cutoffs change as the frequency distribution ("f") for the racial groupings change from one survey cycle to the next. These rules are summarized below.

- If the PSU is within one of the 54 largest MSA in the U.S. it is classified as "urban," otherwise it is classified as "nonurban."
- If the percentage of Hispanic students in the PSU exceeded the percentage of non-Hispanic black students, then the PSU is classified as Hispanic. Otherwise it is classified as non-Hispanic black.
- Hispanic urban and Hispanic nonurban PSUs were classified into four density groupings, depending upon the percentages of Hispanics in the PSU.
    - For urban, high Hispanic PSU, the percentage cut points used to define the groups were 26, 42, and 58%.
    - For nonurban, high Hispanic PSU, the percentage cut points used to define the groups were 24, 48, and 68%.
- Non-Hispanic Black urban and non-Hispanic black nonurban PSUs also were classified into four groupings, depending upon the percentages of non-Hispanic blacks in the PSU.
    - For urban non-Hispanic black PSUs, the percentage cut points used to define the groups were 26, 40, and 54%.
    - For nonurban High non-Hispanic black PSUs, the percentage cut points used to define the groups were 20, 34, and 54%.

Allocation of the PSU Sample

We designed and selected a sample of 85 PSUs that were allocated in proportion to student enrollment to maximize overall precision. We made adjustments to the initial allocation to ensure that racial/ethnic minority targets would be met. Specifically, the adjustments rounded fractional allocations, ensured that each stratum would have at least two sampled PSUs, and added balance to the distribution across strata.

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[5] Dalenius, T., & Hodges, J. L. (1959). Minimum Variance Stratification. *Journal of American Statistical Association*, 54, 88−101.

Exhibit 2-2 presents the allocation of the PSU sample to strata.

EXHIBIT 2-2: STRATUM DEFINITION AND PSU ALLOCATION TO STRATA

Predominant Minority	Urban/Rural	Density Group Number	Stratum Code	Student Population	Number of Sample PSUs
Non-Hispanic Black	Urban	1	BU1	2,720,181	7
		2	BU2	975,490	4
		3	BU3	908,299	2
		4	BU4	516,712	2
	Nonurban	1	BR1	3,937,157	9
		2	BR2	1,503,403	5
		3	BR3	1,026,612	3
		4	BR4	313,063	2
Hispanic	Urban	1	HU1	3,530,556	10
		2	HU2	2,429,442	8
		3	HU3	1,865,988	6
		4	HU4	2,106,242	5
	Nonurban	1	HR1	4,427,215	14
		2	HR2	1,284,402	3
		3	HR3	988,655	3
		4	HR4	523,491	2

2.2.2 Schools

Linking into Second-stage Sampling Unit (SSU)

FIGURE 2-2: LINKED SCHOOL CONSTRUCTION AND GRADE SAMPLING FOR HIGH SCHOOLS

Component School B (Whole)	Component School A (Fragment)
Grade 9	
Grade 10	Grade 10
Grade 11	Grade 11
Grade 12	Grade 12

Schools were classified as “whole” for high schools if they have all high-school grades 9 through 12, and whole for middle schools if they had all grades 6–8. Otherwise, they were considered a “fragment” school. Fragment schools formed component schools that were linked with other schools (fragment or whole) to form a linked school that has all four grades. This process is illustrated in Figure 2-2, where “Component School A” is linked with “Component School B,” to form a linked school. We linked schools before sampling using an algorithm developed for use in the national YRBS that links geographically proximate schools. Linked schools were treated as second-stage sampling units (SSUs) with selection performed at the grade level, as described below.

Stratification

SSUs were stratified by school level (middle and high) and by size. Middle schools were those that contained any of grades 6 through 8, and high schools were those that contained any of grades 9 through 12. Schools that contained a mix of high and middle school grades were split into two sampling units, or one for each level.

SSUs also were stratified by school size into small, medium, and large strata on the basis of their ability to support less than one, one, or two class selections per grade. Operationally, large SSUs contained at least 56 students at each grade level, medium SSUs contained between 28 and 55 students per grade, and small SSUs contained less than 28 students at any grade level.

2.2.3 Sample Sizes

This section provides the derivation of the NYTS sample sizes driven by target precision requirements overall and in key subgroups. The required student yields, or numbers of participating students, are translated into the necessary numbers of sample schools, and sample PSUs, using historical participation rates.

The NYTS is designed to produce accurate estimation within a margin of error (MOE) of 5% at a 95% precision level for the following key subgroup estimates:

- *Middle and high school (school level):* middle school students in total (grades 6–8 combined) and high school students in total (grades 9–12 combined);
- *Grade*: individual grades 6, 7, 8, 9, 10, 11, and 12;
- *Sex*: males and females in total, by school level (male middle school students, female high school students), and by individual grade (6-grade males, 6-grade females);
- *Race/Ethnicity*: in total and by school level (e.g., Hispanic middle school students).

The sample sizes are developed to support analysis by individual grade and by sex without any special considerations in the sampling plan. Design effects were assumed by the design to be relatively small for subgroups that cut across schools; therefore, estimates by sex will have better precision than other subgroups. Thus, the designed confidence intervals were ± 3%. Because the design is expected to yield a greater number of completed surveys from high school students than from middle school students, overall estimates are anticipated to be more precise at the high school level than those at the middle school level. Moreover, because within grade estimates by sex have slightly larger standard errors than those for estimates by grade alone, estimates of sex are expected within ± 5%.

The 2015 NYTS sampling design aimed at balancing student yields by grade unlike the 2012 and 2014 sample designs which aimed at balance by school level (middle and high school). Previous designs aimed at balance by school level had targets of 10,000 students per level. For the 2015 NYTS, the target sample sizes correspond to approximately 3,000 participating students per grade and so they also ensure the precision of estimates by individual grade (e.g., sex by grade subgroup estimates on the basis of about 1,500 students).

Across the ten previous cycles of the NYTS, the school participation has averaged 86.5%, with a low of 75.4%. Student participation has averaged 90.5% with a low of 87.6%. Historical participation rates at both school and student levels, which guide the sampling design and sample sizes, are summarized in Exhibit 2.3. In calculating the sample sizes for the 2015 NYTS, we made our approach more robust by assuming a conservative combined rate (student x school) of 77%, which was slightly lower than the historical overall response rate from 1999-2013 of 78.3% (90% school x 85.5% student). The 2014 response rates were not yet available when the 2015 sampling plan was created.

EXHIBIT 2-3: HISTORICAL SUMMARY OF NYTS PARTICIPATION RATES

YEAR	School Participation	Student Participation	Overall
1999	90.3%	93.2%	84.2%
2000	90.0%	93.4%	84.1%
2002	83.1%	90.6%	75.3%
2004	92.7%	87.9%	81.5%
2006	91.6%	87.6%	80.2%
2009	92.3%	91.9%	84.8%
2011	83.2%	88.0%	73.2%
2012	80.3%	91.7%	73.6%
2013	75.4%	90.7%	68.4%
2014	80.2%	91.4%	73.3%
Average over all previous cycles	85.91%	90.64%	79.61%

Schools were classified by size based on grade-level enrollments. This ensures that a sampled school of a given size classification is able to support the student sample sizes summarized in Exhibit 2-4.

The NYTS sample size calculations are based on the following assumptions:

- The main structure of the sampling design will be consistent with the design used to draw the sample for prior cycles of the NYTS.
- The selection of a minimum of one SSU at the high school level and one SSU at the middle school level within each PSU. Some PSUs are selected to provide up to four extra schools. A PSU is a county, a group of contiguous counties, or a section of a county if too large.
- SSUs with at least 56 students per grade are considered large, and those among the others with 28 students per grade are considered medium; otherwise, they are considered small.

- On average, each selected class includes 28 students (on the basis of historical averages).
- For SSUs classified as large, we sample double the amount of students in 46% of these schools, by sampling eight classes instead of four.
- A 77% overall response rate (based on historical averages) calculated as the product of the school and student response rate.

Based on these assumptions, 85 PSUs were selected as the basis for the sample. Within each of 85 sample PSUs, two large schools were drawn, one at the middle school level to supply students in grades 6 through 8, and one at the high school level to supply students in grades 9 through 12. In addition, 10 and 15 PSUs were independently sub-sampled to supply medium and small SSUs at each level, respectively. The anticipated number of students selected from all sample schools was 27,789 students (before non-response).

Exhibit 2-4 provides a detailed calculation of designed sample sizes across school level and school size categories.[6] Section 3.4 compares these projections to the actual sample yields.

[6] In this exhibit, the schools are secondary sampling units (SSUs), or "virtual schools", created by combining actual, physical schools so that each virtual school unit has a complete set of grades for the level. The virtual schools are expanded to physical schools.

EXHIBIT 2-4: PLANNED SAMPLE SIZES FOR THE 2015 NYTS

PSU	Size	# of SSUs	Number of Schools Sampled	Number of Classes per School	Number of Students per Class	Number of Sampled Students Prior to Attrition	Combined School and Student 77% Response Rate
85	Large High School	85	Double classes: 39	8	28	8,758	6,744
			Single classes: 46	4	28	5,141	3,958
	Large Middle School	85	Double classes: 39	6	28	6,569	5,058
			Single classes: 46	3	28	3,856	2,969
	Large Total	**170**				**24,324**	**18,729**
10 (sub-sample)	Medium High School	10	10	4	28	1,120	862
	Medium Middle School	10	10	3	28	840	647
	Medium Total	**20**				**1,960**	**1,509**
15 (sub-sample)	Small High School	15	15	3.8	18.1	1,030	793
	Small Middle School	15	15	2.8	11.2	475	366
	Small Total	**30**				**1,505**	**1,159**
	Overall Total	**220**				**27,789***	**21,397**

*Note that this was anticipated number of students in all sampled schools, and the actual number of sampled students is derived only from participating schools (and is thus considerably lower).

2.2.3.1 Middle School and High School Estimates

Estimates by school level are required to support separate analysis of students across middle school grades (6, 7, and 8) and high school grades (9, 10, 11, and 12). However, schools tend to vary in their grade structures, an inconsistency that compromises the ability to easily and efficiently link schools for sampling purposes in a manner that also uniformly divides students by grade. For example, 9th grade students are served by both junior high schools with grades 7–9 and by high schools with grades 9–12. As a result, we have developed the school linking approach described in Section 2.2.2 that was applied independently for high schools and middle schools.

2.2.3.2 Grade Estimates

The designed sample sizes are approximately balanced for school-level and for grade-level groupings. By targeting nearly 3,000 students per grade, the sample ensures that estimates at the grade level achieve the required precision levels.

2.2.3.3 Sex Group Estimates

The large sample size permitted analysis by sex without any special considerations in the sampling plan. During the class selection process, frames of eligible classes from co-educational schools in which classrooms were segregated by sex (i.e., an all-male or all-female class) were avoided, if possible.

2.2.3.4 Race/Ethnicity Group Estimates

In order to support separate analysis of the data for non-Hispanic white, non-Hispanic black and Hispanic students, in total and by school level, adequate sample sizes were required by the design for subgroups defined by: 1) school level by racial grouping; or 2) by sex grouping. Sample sizes were not designed, however, to support detailed analyses by sex and school level within racial/ethnic subgroups (e.g., middle school Hispanic males).

2.3 Sampling Methods

This section describes the methods used in the selection of PSUs, schools, grades, and classes of students. In this process, we define the probabilities of selection associated with the various sampling stages as follows:

- Probability of selecting PSUs;
- Probability of selecting schools;
- Probability of selection of grades;
- Probability of selecting classes and students.

These probabilities provide the basis for the sampling weights discussed in Chapter 4.

The overall probability of selection for a student is the product of the probability of selection of the PSU, which contains a group of schools, multiplied by the conditional probability of selecting the student's school and the conditional probability of selecting the student's class. These steps are detailed in the selection below.

2.3.1 Primary Sampling Unit

Selection

Within each first-stage stratum, the PSUs were sorted by five-digit ZIP Code to attain a form of implicit geographic stratification. Implicit stratification, coupled with the PPS sampling method described below, ensures geographic sample representation. With PPS sampling, the selection probability for each PSU is proportional to the PSU's measure of size.

The following systematic sampling procedures were applied to the stratified frame to select a PPS sample of PSUs.

- Select 85 PSUs with a systematic random sampling method within each stratum. The method applies within each stratum 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.

- Subsample at random 10 of the sample PSUs for the medium school sample for each school level.
- Subsample at random 15 of the sample PSUs for the small school sample for each school level.

Although the revised sampling design is focused on balancing student yields by grade, rather than by school level, sampling is still done separately for middle schools and high schools.

Probability

If MOS_{klm} is the measure of size for school *k* in PSU l in stratum *m* and if K_m is the number of PSUs to be selected in stratum *m*, then P^p_{lm} is the probability of selection of PSU *l* in stratum *m*:

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

2.3.2 Schools

Selection

For large schools, one high school and one middle school were selected with PPS systematic sampling within a PSU. The schools were selected into the sample with probability proportional to the measure of size. (MOS).

Small and medium schools were sampled independently from large schools; they were set in two separate strata sampled at lower rates. This approach was implemented by drawing subsample PSUs for small and medium school sampling as described earlier. One small school or medium school was then selected in each subsampled PSU with probability proportional to the MOS.

Replacement of Schools/School Systems

We did not replace refusing school districts, schools, classes, or students. We allowed for school and student nonresponse by inflating the sample sizes to account for nonresponse. With this approach, all schools can be contacted in a coordinated recruitment effort, which is not possible for methods that allow for replacing schools.

Probability

The probability of selecting large school k in PSU l and stratum m, P^{LS}_{klm}, at each level was computed as follows:

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

For medium schools, one school was drawn from each of 10 subsampled PSU at each level, so the probability of selection of a medium school then becomes,

$$P^{MS}{}_{klm} = (10/85)\left(\frac{MOS_{klm}}{MOS_{.lm}} \right)$$

For small schools, one school was drawn from each of 15 subsampled PSU at each level, so the probability of selection of a small school then becomes (the same for each level)

$$P^{SS}{}_{klm} = (15/85)\left(\frac{MOS_{klm}}{MOS_{.lm}} \right)$$

2.3.3 Grades

Selection

Except for linked schools, all eligible grades were included in the class selection for each school.

In linked schools, grades were selected independently. One component school was selected to provide classes at each grade level, and grades within component schools were drawn with probability proportional to grade enrollment.

Probability

Most SSUs in the sample contained one component school. In these cases, all eligible grades were selected so that the probability of selecting a grade was 1.0.

In SSUs that were made up of component schools, the selection of each component school at each grade is made with PPS sampling. The school selections from each component school at each grade level were made independently.

We denote this P^{G}_{jklm} the probability of selecting grade j in SSU k, in PSU l, stratum m. For the j^{th} grade within SSU k, this probability is equal to the ratio of the number of students at grade j in the component school to the total enrollment in grade j across all component schools within the SSU.

2.3.4 Classes

Selection

In large schools, an average of 1.46 classes per grade were selected by selecting 2 classes per grade in 46% of the selected large schools and one class per grade in the remaining large schools. The double class sampling took place in schools with greater than 3% non-Hispanic black enrollment and one class per grade in the remaining schools.

One class per grade was selected in medium schools. In small schools, that is, those that could not support a full class selection at each grade, all students in all eligible grades were taken into the sample.

All students in a selected class who could complete the survey without special assistance were considered eligible and offered the opportunity to participate in the survey. Refusing students were not replaced. Nonresponse at the student level was accounted for in the sample size using an average per class yield that assumed student response rates derived from historical experience with the NYTS.

A set of classes was identified for each school at each grade level such that every student in a given grade level was enrolled in exactly one of the classes in the set. For example, a required English course might be used. If the school's estimated non-Hispanic black enrollment exceeded 3%, two classes were randomly selected, without replacement, from the list. Otherwise, one class was randomly selected. Selections were made at all eligible grade levels in the school.

Probability

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 one or two 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 (i.e., $1/C_{jklm}$ or $2/C_{jklm}$).

Note that the probability of student selection within a class does not vary by race, ethnicity, or sex. We denote this probability as P^C_{ijklm} as the probability of selecting class *i* in grade *j*, school *k*, PSU *l*, stratum *m*. Since every student in a selected class is also selected, the probability of selecting any student in class *i*, grade *j*, school *k*, PSU *l*, stratum *k*, is also equal to P^C_{ijklm}.

CHAPTER 3—NYTS DATA COLLECTION

3.1 Survey Instrument

The NYTS collects data on key short-term, intermediate, and long-term tobacco prevention and control outcome indicators. The 2015 survey instrument included a total of 81 questions, with the first 5 collecting student demographic information and the remaining measuring 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.

3.2 Recruitment Procedures

The schools selected to participate in the 2015 NYTS were located in 36 different states. Recruitment began in May 2014 with calls to State Departments of Education and Health. Letters of support were obtained from various state agencies and used in mailings to districts and schools. 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 an electronic calendar on a secure shared drive to facilitate communication and to avoid scheduling two schools for the same data collector on the same day.

3.3 Survey Administration

Survey administration in the schools began on February 9, 2015, immediately after data collector training, and continued until June 19, 2015. Each data collector visited an average of three schools per week. While the details of each data collection varied, there were six core steps followed for every school: 1) pre-contact call with the principal or lead contact prior to arrival at the school; 2) entry meeting with the principal or lead contact; 3) entry meeting with teacher or group of teachers prior to survey administration; 4) survey administration; 5) post-survey meeting with the teacher or teachers; and 6) post-survey meeting with the principal or lead contact prior to leaving the school. Most survey administrations could be completed in 1 day, while at other times, due to the number of classes selected or alternating block schedules, the data collector needed to return for a second day. Procedures were designed to protect students' privacy by assuring that student participation was anonymous and voluntary. Students completed a self-administered scannable questionnaire booklet via pencil and paper.

3.3.1 Data Collection Staffing

Data collectors were recruited from a pool of previously trained data collectors, as well as retired teachers associations, school health networks, and a variety of health education organizations. Data collector training was conducted on February 4–6, 2015.

Key components of the training included the following:

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

3.3.2 Field Procedures

After schools had been recruited, classes selected, and a date scheduled, each school received a packet of pre-survey materials. These materials included all the information necessary to prepare the school for data collection. Teacher packets contained the parental permission forms that had to be given out 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. Passive parental permission forms, or forms returned only if the parents do not want their child to participate, were sent approximately 1 week prior to the scheduled date of data collection in the majority of schools. Active parental permission forms, forms that must be returned with the parent's signature in order for the child to participate, were sent out at least 2 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.

On a weekly basis, data collectors received mailings containing their assignments for the coming week, travel and logistics information, and their must-read weekly bulletin. Weekly bulletins underlined key performance issues, corrected misconceptions, provided consistent direction on any procedural changes, and kept everyone abreast of the latest must-have information. In addition to these mailings, boxes of survey supplies were sent to data collectors, either to the data collector's home or hotel. These boxes contained all supplies necessary for completing the data collection, including questionnaires, data envelopes, field forms, and pencils. Data collectors were supplied with extra materials for emergency packs as well, which they carried with them at all times.

3.3.3 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 such 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, school homerooms were used as the frame for class selection.

3.4 Participation Rates

Across the ten previous cycles of the NYTS, the school participation has averaged 86%, with a low of 75%. Student participation has averaged 91% with a low of 88%, and the overall response rate has averaged 80%. To be conservative, we assumed slightly lower values in developing the sample design for the 2015 NYTS: an assumed overall participation rate of 77%.

The actual response rates in 2015 differed from our projections. The 2015 NYTS survey attained an actual school participation rate of 72.6 % and a student participation rate of 87.4%. The overall participation rate, the product of the school-level and student-level participation rates was 63.4%. While the participation rate is lower than the levels assumed in the projections, the shortfall has no meaningful impact on the estimation precision. As seen below, however, some design modifications may be recommended to increase the yields achieved for black students.

The 2015 NYTS data file contains responses from 17,711 students compared to the 21,397 responding students anticipated by the design. Exhibit 3-1 shows that student yields were lower than targeted for non-Hispanic Blacks. Among Hispanics, yields far exceeded the targets at both levels. Exhibit 3-2 shows number of respondents by grade.

EXHIBIT 3-1: SAMPLE YIELDS FOR NON-HISPANIC BLACK AND HISPANIC STUDENTS BY SCHOOL LEVEL

Subgroup	Projected Participants	Actual Participants
Middle School non-Hispanic Blacks	1,775	1,310
Middle School Hispanics	1,775	2,294
High School non-Hispanic Blacks	1,975	1,462
High School Hispanics	1,975	2,763

EXHIBIT 3-2: SAMPLE YIELDS FOR STUDENTS BY GRADE

Subgroup	Projected Participants	Actual Participants
6th Grade	3,000	2,552
7th Grade	3,000	2,845
8th Grade	3,000	2,773
9th Grade	3,000	2,512
10th Grade	3,000	2,509
11th Grade	3,000	2,282
12th Grade	3,000	2,130
Unknown	N/A	18

CHAPTER 4—WEIGHTING OF NYTS RESPONSE DATA

4.1 Overview

This section describes the procedures used to weight the data collected in the NYTS 2015. The process involved the steps outlined below:

- Sampling weights;
- Nonresponse adjustments;
- Weight trimming;
- Poststratification to national estimates of racial totals by grade, sex and school type.

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 poststratify the data to known sampling frame characteristics.

4.2 Sampling Weights

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

The NYTS computation of sampling weights begins at the student sampling stage, and then moves to the school and PSU sampling stages. This sequence allows the student sampling weights to incorporate adjustments for student nonresponse. These adjustments, described next, use enrollment data by sex and by grade collected for each participating school. Because the process begins with the student weights within a given grade, school and PSU, we refer to these weights as conditional weights.

4.2.1 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 (see Appendix B) 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.

We denote the student selection weight 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 is 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* is defined by a sequence of rules that depends on the number of responding students. This is done to avoid large weights for classes with low numbers of respondents. This process operates entirely within schools.

Initially, the weighting class is defined by grade and sex within each school. We then combine weighting classes if the weight for the class exceeds a maximum value, C. This cap *C* is computed using the following equation:

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

The combination sequence first groups males and females within grade. Both the cap and the weight are then recomputed. If the weight still exceeds the cap, grades are combined. The process is repeated, and if the student weight still exceeds the cap, the school is taken as the weighting class.

This has the effect, within 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 is collapsed to the school level.

4.2.2 School Sampling Weights

For large schools, the partial school weight is 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 is:

$$W^{SS}{}_{klm} = (85/15)\left(\frac{MOS_{.lm}}{MOS_{klm}}\right) = \frac{1}{P^{SS}{}_{klm}}$$

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

$$W^{MS}{}_{klm} = (85/10)\left(\frac{MOS_{.lm}}{MOS_{klm}}\right) = \frac{1}{P^{MS}{}_{klm}}$$

4.2.3 Grade Sampling Weights

Grade selection occurs within linked schools where the grade is 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, is simply the inverse of the probability of selection described in Section 2.4. In a non-linked school, the weight is 1.0. We denote the grade weight as $W^{G}{}_{jklm}$.

4.2.4 PSU Sampling Weights

The weight of the PSU is 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. (Subsampling of PSUs also was conducted for the large high schools.) This PSU subsampling component of the PSU weight is accounted for in the school selection probability and corresponding weight.

4.2.5 Overall Sampling Weight

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

4.3 Nonresponse Adjustments

Nonresponse adjustment of weights is important to reduce potential bias incorporated into surveys from differences between responding and nonresponding schools included in the sample. In the 2015 NYTS cycle, the 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 defines nonresponse adjustment cells in a more tailored and systematic approach stemming the from non-response analysis. Specifically, the definition of the most appropriate nonresponse adjustment weighting cells followed these steps:

1. Conduct bivariate analysis to identify key predictors of school non-response and student non-response;
2. Conduct multivariate logistic regression analysis, or response propensity models, including the subset of key predictors identified in 1), to identify significant predictors of non-response at both levels;
3. Develop non-response adjustment weighting cells based on the significant predictors while incorporating information about correlations between predictors and resulting cell sizes.

Variables identified in the non-response bivariate and multivariate analyses included the following:

- Urban status;
- School type (public/private);
- A range of socio-economic status (SES) indicators and concentrations of minority students, all of which are mutually correlated.

These analyses are detailed in the nonresponse analysis report. The subset of variables selected for defining weight adjustment cells is effectively reduced by eliminating variables with high pairwise correlations and limiting to variables with adequate representation of responding schools. As a result, the variables used in creating nonresponse adjustment cells were school type, urban/rural designation of PSU, and categorization of schools as predominantly Hispanic (above or below median). Because of the small number of private schools included in the sample, they were included as their own category in the nonresponse adjustment cells. Nonresponse adjustment was conducted separately for middle schools and high schools.

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

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

The student weight adjusted for nonresponse is then:

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

The school response rates by weighting cells along with resulting nonresponse adjustments are presented in Exhibit 4-1.

EXHIBIT 4-1. RESPONSE RATES AND CORRESPONDING NON-RESPONSE ADJUSTMENT BY NON-RESPONSE ADJUSTMENT CELLS

Stratum (Non-Response)	Sampled Schools	Responding Schools	Percent Responding	Non-Response Adjustment
Middle School				
Private	15	6	40.00%	1.9
Public/Nonurban/Low Hispanic	34	27	79.41%	1.3
Public/Urban/Low Hispanic	20	16	80.00%	1.2
Public/Nonurban/High Hispanic	32	24	75.00%	1.4
Public/Urban/High Hispanic	39	30	76.92%	1.3
Total	**140**	**103**	**73.57%**	**.**
High School				
Private	15	8	53.33%	1.9
Public/Nonurban/Low Hispanic	29	26	89.66%	1.1
Public/Urban/Low Hispanic	22	15	68.18%	1.5
Public/Nonurban/High Hispanic	23	17	73.91%	1.4
Public/Urban/High Hispanic	26	16	61.54%	1.7
Total	**115**	**82**	**71.30%**	
Overall Total	**255**	**185**	**72.55%**	

For the 2015 NYTS, a total of 70 schools did not respond. The final analytic file contains student responses from schools in 53 PSUs, with approximately 72.6% of schools responding overall (73.6% for middle schools and 71.3% for high schools). The largest adjustment was for private middle and high schools where only 6 of 15 and 8 of 15 schools, responded respectively. The resulting nonresponse adjustment factor was 1.9 for both cells.

4.4 Post-stratification and Trimming

The final two steps in the weighting process include trimming and post-stratification. Trimming procedures are used to control the weight variability and reduce its impact on survey variances. Post-stratification methods ensure that weighted totals sum to population control totals and therefore, minimize the potential for biases due to non-response and non-coverage.

In previous NYTS cycles, extreme weights were first trimmed before being post-stratified to match public and private school enrollment counts. When trimming is performed prior to post-stratification it can be less effective at controlling weight variability added back by post-stratification step. If trimming follows post-stratification, on the other hand, then final weights would not sum to known population control totals, and the bias reduction benefits of post-stratification would be diluted.

The solution developed and used in the 2015 NYTS is an iterative approach that combines post-stratification and trimming.[7,8] The methods incorporate a model-based approach to variable selection in weight trimming while controlling for extreme variability in weights across sampling units. Iterative post-stratification, or raking, approaches have long been used in weighting survey data to allow additional post-stratification variables and categories.[9,10] By combining the two iterative methods in one approach, the rake-trim method ensures that trimmed weights retain their variance-reducing feature after post-stratification. Conversely, it also ensures that post-stratified weights add up to control totals.

Similar to weighting, the raking and trimming methods were conducted separately for middle schools and high schools. In each iteration of the raking method used in the 2015 NYTS, post-stratification is performed along two dimensions: a) school type (public or private)/ grade/ race-ethnicity, and b) school type/ grade/ gender. These two classes are defined so that control totals are known and cells have reasonable size. In odd year iterations, public schools are raked to totals by grade and race-ethnicity while private schools are raked to grade totals. In even year iterations, public schools are raked to grade and race-ethnicity marginal totals while private schools are still raked to grade totals. Within the same iteration, this step is followed by the trimming step which truncates (or "caps") the weight using the overall weight distribution (*i.e.* percentiles). The trimming method uses the interquartile range (IQR) as the basis for a threshold for weights that are excessively large. Specifically, any weights that exceed the median weight plus 4 times the IQR are trimmed.[3] The excess weight is then distributed among the observations within each cell to ensure that effective post-stratification totals are preserved.

National estimates of race-ethnicity and gender percentages by school type and grade were obtained from two sources:

- Private school enrollments by grade and five racial/ethnic groups were obtained from the Private School Universe Survey (PSS) School Year 2011-12, the most recent PSS dataset available;

- Public school enrollments by grade, sex, and five racial/ethnic categories were obtained from the Common Core of Data (CCD) Public Elementary/Secondary School Universe Survey: School Year 2013-14, the most recent CCD data file available.

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

[8] Izrael D, Battaglia MP, Frankel MR. (2009). Extreme survey weight adjustment as a component of sample balancing (a.k.a. Raking), Paper 274-2009, SAS Global Forum 2009.

[9] Potter F. (1998). Survey of procedures to control extreme sampling weights. ASA Proceedings of the Section on Survey Research Methods, 446-457.

[10] Oh HL, and Scheuren F. (1978). Some Unresolved Application Issues in Raking Ratio Estimation. 1978 Proceedings of the Section on Survey Research Methods, Washington, DC: American Statistical Association, pp. 723-728.

Both databases are produced by the National Center for Education Statistics (NCES). Raw school-level data files were downloaded and processed to mirror eligibility requirements imposed on the sampling frame. Specifically, eligibility was defined in terms of a school type variable present on both files. Exhibit 4-2 provides the details of this categorization. In both cases, eligible schools were defined as "regular" schools—that is, those schools left after schools that either serve special populations or pull students from other eligible schools are removed. Furthermore, public schools were limited to those that had not closed since the time of the last CCD survey.

EXHIBIT 4-2. ELIGIBILITY CRITERIA FOR CONTROL TOTALS

Value of School Type	Public School (CCD) Coding	Private School (PSS) Coding	Eligibility Status
1	Regular	Regular	Eligible
2	Special Education	Montessori	Not Eligible
3	Vocational	Special Program Emphasis	Not Eligible
4	Alternative/Other	Special Education	Not Eligible
5	-unused-	Career / Technical / Vocational	Not Eligible
6	-unused-	Alternative / Other	Not Eligible
7	-unused-	Early Childhood	Not Eligible

The private school and public school databases were then combined to produce the enrollments for all schools and to develop population percentages to use as controls in the post-stratification step. Exhibit 4-3 gives counts of schools and students by grade for private and public schools by school eligibility criteria.

EXHIBIT 4-3. COUNTS OF SCHOOLS AND STUDENTS BY SCHOOL TYPE AND ELIGIBILITY STATUS

Type / Grade		Ineligible Counts		Eligible Counts		Total (Raw File)	
		Schools	Students	Schools	Students	Schools	Students
Public	6	7,166	52,686	70,132	7,385,550	77,298	7,438,236
	7	8,108	63,882	55,116	7,367,876	63,224	7,431,758
	8	8,818	81,746	55,224	7,309,568	64,042	7,391,314
	9	12,824	245,792	41,360	7,814,120	54,184	8,059,912
	10	13,676	277,770	38,914	7,358,854	52,590	7,636,624
	11	13,846	320,340	38,334	6,785,260	52,180	7,105,600
	12	13,656	433,416	37,976	6,518,688	51,632	6,952,104
	Total	**78,094**	**1,475,632**	**337,056**	**50,539,916**	**415,150**	**52,015,548**
Private	6	2,178	20,049	15,355	306,460	17,533	326,509
	7	2,054	19,233	14,553	305,170	16,607	324,403
	8	2,125	20,517	14,334	305,489	16,459	326,006
	9	1,797	22,450	6,922	281,606	8,719	304,056
	10	1,745	23,017	6,572	279,592	8,317	302,609
	11	1,678	22,603	6,281	275,027	7,959	297,630
	12	1,599	22,462	6,167	271,152	7,766	293,614
	Total	**13,176**	**150,331**	**70,184**	**2,024,496**	**83,360**	**2,174,827**
Public and Private	6	9,344	72,735	85,487	7,692,010	94,831	7,764,745
	7	10,162	83,115	69,669	7,673,046	79,831	7,756,161
	8	10,943	102,263	69,558	7,615,057	80,501	7,717,320
	9	14,621	268,242	48,282	8,095,726	62,903	8,363,968
	10	15,421	300,787	45,486	7,638,446	60,907	7,939,233
	11	15,524	342,943	44,615	7,060,287	60,139	7,403,230
	12	15,255	455,878	44,143	6,789,840	59,398	7,245,718
	Total	**91,270**	**1,625,963**	**407,240**	**52,564,412**	**498,510**	**54,190,375**

Overall, the total number of eligible students is 52,564,412. This total matches the sum of the adjusted weights prior to scaling. The control totals used in even and odd iterations of post-stratification are included below in Exhibits 4-5a and 4-5b.

Exhibit 4-4a. Control Totals Used in Even Iterations of the Raking and Trimming Method

School Type	Grade	Race/Hispanic Origin	Control Total
Private	6	Combined	290,654
Private	7	Combined	285,467
Private	8	Combined	283,706
Private	9	Combined	265,350
Private	10	Combined	260,393
Private	11	Combined	255,640
Private	12	Combined	252,489
Public	6	Non-Hispanic Asian and Pacific Islander	185,862
Public	6	Non-Hispanic Black	583,263
Public	6	Hispanic	964,949
Public	6	Non-Hispanic Native American	39,448
Public	6	Non-Hispanic White	1,911,126
Public	7	Non-Hispanic Asian and Pacific Islander	185,600
Public	7	Non-Hispanic Black	595,309
Public	7	Hispanic	967,634
Public	7	Non-Hispanic Native American	39,941
Public	7	Non-Hispanic White	1,955,941
Public	8	Non-Hispanic Asian and Pacific Islander	188,206
Public	8	Non-Hispanic Black	596,374
Public	8	Hispanic	943,113
Public	8	Non-Hispanic Native American	40,164
Public	8	Non-Hispanic White	1,972,189
Public	9	Non-Hispanic Asian and Pacific Islander	182,797
Public	9	Non-Hispanic Black	653,815
Public	9	Hispanic	981,536
Public	9	Non-Hispanic Native American	43,315
Public	9	Non-Hispanic White	2,032,458
Public	10	Non-Hispanic Asian and Pacific Islander	183,595
Public	10	Non-Hispanic Black	581,894
Public	10	Hispanic	883,635
Public	10	Non-Hispanic Native American	39,503
Public	10	Non-Hispanic White	1,963,264
Public	11	Non-Hispanic Asian and Pacific Islander	183,350
Public	11	Non-Hispanic Black	515,161
Public	11	Hispanic	783,554
Public	11	Non-Hispanic Native American	34,982
Public	11	Non-Hispanic White	1,872,334
Public	12	Non-Hispanic Asian and Pacific Islander	180,976
Public	12	Non-Hispanic Black	483,636

School Type	Grade	Race/Hispanic Origin	Control Total
Public	12	Hispanic	727,482
Public	12	Non-Hispanic Native American	33,737
Public	12	Non-Hispanic White	1,845,218

EXHIBIT 4-4B. CONTROL TOTALS USED IN ODD ITERATIONS OF THE RAKING AND TRIMMING METHOD

School Type	Grade	Gender	Control Total
Private	6	Combined	290,654
Private	7	Combined	285,467
Private	8	Combined	283,706
Private	9	Combined	265,350
Private	10	Combined	260,393
Private	11	Combined	255,640
Private	12	Combined	252,489
Public	6	Male	1,887,892
Public	6	Female	1,796,756
Public	7	Male	1,918,000
Public	7	Female	1,826,425
Public	8	Male	1,912,185
Public	8	Female	1,827,861
Public	9	Male	2,008,655
Public	9	Female	1,885,266
Public	10	Male	1,861,965
Public	10	Female	1,789,926
Public	11	Male	1,711,004
Public	11	Female	1,678,377
Public	12	Male	1,642,782
Public	12	Female	1,628,267

Comparison of New Nonresponse Adjustment and Post-Stratification Method with Previous Method

Comparisons with the previous method of nonresponse adjustment and post-stratification demonstrate that the new method had minimal impact on the weighted prevalence estimates but substantially reduced variance. The coefficient of variation for the weights (CV) decreased using the new method compared to the previous method. Consequently, the variance impact of unequal weighting has been substantially reduced with the new method. The design effect due to unequal weighting can be expressed as $1 + CV^2$. This reduction is demonstrated empirically next for a range of key prevalence estimates computed for the 2015 NYTS.

Exhibit 4-5 provides an example comparison of weighted estimates and standard errors from the questions on current cigarette and flavored cigarette use, using new method and previous method. While the weighted estimates changed very little (in relative terms, 3 to 4%), the standard errors shrunk by approximately 25% among middle school students and 10-12% among high school students.

EXHIBIT 4-5. PERCENT CHANGE IN WEIGHTED ESTIMATES AND STANDARD ERRORS COMPARING NEW METHOD AND PREVIOUS METHOD OF POST-STRATIFICATION IN THE NYTS

	Weighted Estimate (%)	Percent Change in Estimate (%)	Standard Error	Percent Change in Standard Error (%)
Middle School				
Current Cigarette Use				
Previous Method	2.30	2.6	0.43	25.6
New Method	2.24		0.32	
Flavored Cigarette Use				
Previous Method	1.19	4.2	0.20	25.0
New Method	1.14		0.15	
High School				
Current Cigarette Use				
Previous Method	9.77	4.0	0.86	10.5
New Method	9.38		0.77	
Flavored Cigarette Use				
Previous Method	3.35	2.7	0.32	12.5
New Method	3.44		0.28	

4.5 Analysis Strata and Variance Estimation

Sampling variances for complex sampling designs can be estimated using one of several methods, including linearized estimators and balanced repeated replication. These methods are implemented with a variety of software packages, including SUDAAN, WesVar, Stata and SAS using special sample survey procedures (such as Proc SurveyMeans in SAS Version 9). The 2014 NYTS data were prepared for estimating variances using the linearized estimators method.

Because estimates are typically reported separately for middle schools and high schools, analysis strata need to ensure that each stratum has two or more PSUs for variance estimation within each subpopulation (middle schools and high schools separately).

As noted earlier, the allocation ensured that every stratum had at least two PSUs in the sample. This does not necessarily translate to two PSUs with valid student data for each school level (middle schools and high schools) in every stratum due to the effects of nonresponse at the school level. In particular, nonparticipating schools may lead to PSUs without student data for a given school level.

Exhibit 4-6 displays the correspondence between the sampling strata and the analysis strata, which are represented by two variables on the analysis file. As analyses are typically conducted separately for middle and high schools, we ensure that each stratum is represented in the data file with at least two PSUs for each school level separately. All strata/level combinations but four had at least two PSUs, two combinations for middle schools and two for high school. As a result, two strata were collapsed for middle and high schools, as shown in this exhibit. Thus, the analytic file contains 14 values in the analysis strata variable for middle and high schools. In addition, stratum codes used in sampling and weighting were converted to a numeric “analysis stratum” code for use in SUDAAN, which requires numeric variables.

Exhibit 4-7 presents selected key survey estimates and their sampling errors estimated using Taylor series linearization method, which is usually employed by NYTS data analysts, and implemented with SUDAAN or similar software (e.g., SAS Proc SurveyMeans). Specifically, the Exhibit presents the percent and standard error of the percent for estimates of current use of selected tobacco products separately for high schools (Exhibit 4-7A) and middle schools (Exhibit 4-7B).

EXHIBIT 4-6. SAMPLING AND ANALYSIS STRATUM CODING SCHEMES

HSMS	Design Stratum	Design Stratum Count	Analysis Stratum	Analysis Stratum Count
HS	BR1	9	BR1	9
HS	BR2	5	BR2	5
HS	BR3	3	BR3	3
HS	BR4	2	BR4	2
HS	BU1	6	BU1	6
HS	BU2	2	BU2	2
HS	BU3	2	BU3+BU4	3
HS	BU4	1		
HS	HR1	11	HR1	11
HS	HR2	2	HR2	2
HS	HR3	3	HR3	3
HS	HR4	2	HR4	2
HS	HU1	6	HU1	6
HS	HU2	7	HU2	7
HS	HU3	1	HU3+HU4	5
HS	HU4	4		
MS	BR1	7	BR1	7
MS	BR2	3	BR2	3
MS	BR3	3	BR3	3
MS	BR4	2	BR4	2
MS	BU1	6	BU1	6
MS	BU2	3	BU2	3
MS	BU3	2	BU3+BU4	3
MS	BU4	1		
MS	HR1	12	HR1	12
MS	HR2	2	HR2	2
MS	HR3	2	HR3+HR4	3
MS	HR4	1		
MS	HU1	8	HU1	8
MS	HU2	6	HU2	6
MS	HU3	4	HU3	4
MS	HU4	5	HU4	5

Exhibit 4-7a: Current Use Estimates for Selected Tobacco Products for High School Students

Product	Overall % (SE)	Female % (SE)	Male % (SE)	Non-Hispanic White % (SE)	Non-Hispanic Black % (SE)	Hispanic % (SE)
Electronic Cigarettes	16.0% (1.0%)	12.9% (1.0%)	19.0% (1.3%)	17.1% (1.3%)	9.5% (0.9%)	16.8% (1.2%)
Cigarettes	9.4% (0.8%)	7.9% (0.7%)	10.8% (1.0%)	10.1% (1.0%)	6.8% (1.9%)	9.5% (1.2%)
Cigars	8.8% (0.5%)	5.8% (0.5%)	11.7% (0.8%)	8.4% (0.7%)	12.6% (1.8%)	7.9% (0.8%)
Hookah	7.2% (0.5%)	7.0% (0.7%)	7.5% (0.5%)	6.5% (0.68%)	7.5% (1.3%)	9.0% (0.6%)
Smokeless Tobacco	5.7% (0.7%)	1.8% (0.4%)	9.5% (1.1%)	7.6% (1.0%)	2.0% (0.6%)	4.4% (0.6%)

Exhibit 4-7b: Current Use Estimates for Selected Tobacco Products for Middle School Students

Product	Overall % (SE)	Female % (SE)	Male % (SE)	Non-Hispanic White % (SE)	Non-Hispanic Black % (SE)	Hispanic % (SE)
Electronic Cigarettes	5.3% (0.4%)	4.8% (0.4%)	5.9% (0.6%)	4.3% (0.5%)	4.5% (0.6%)	8.0% (0.8%)
Cigarettes	2.2% (0.3%)	2.2% (0.4%)	2.3% (0.4%)	2.0% (0.5%)	1.4% (0.3%)	2.6% (0.5%)
Cigars	1.5% (0.2%)	1.3% (0.2%)	1.7% (0.30%)	1.1% (0.3%)	2.3% (0.4%)	2.0% (0.4%)
Hookah	2.0% (0.3%)	2.1% (0.4%)	1.9% (0.29%)	1.5% (0.3%)	1.7% (0.5%)	3.2% (0.5%)
Smokeless Tobacco	1.4% (0.4%)	0.8% (0.2%)	1.9% (0.7%)	1.2% (0.6%)	2.0% (0.5%)	1.7% (0.5%)

Exhibit 4-8 provides example specifications for applying the method with both SAS and SUDAAN for computing weighted prevalence estimates and their estimated variances.

EXHIBIT 4-8: EXAMPLE: ESTIMATES, CURRENT USE BY SCHOOL TYPE

SAS:

SAS:

```
Proc Surveymeans Data=nyts2015 mean;
Var ccigt_r ccigar_r cslt_r chookah_r celcigt_r;
Class ccigt_r ccigar_r cslt_r chookah_r celcigt_r;
Stratum stratum2;
Cluster psu2;
Weight wt;
Domain Schooltype Schooltype*Sex Schooltype*Race_S;
Title "NYTS 2015, 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=nyts2015 Filetype= SAS Design=WR;
Var ccigt_r ccigar_r cslt_r chookah_r celcigt_r;
Catlevel 1 1 1 1 1;
Nest Stratum2 PSU2 / Missunit;
Weight wt;
Subgroup School Sex Race_S;
Levels 2 2 3;
Tables School School*Sex School*Race_S;
Title "NYTS 2014, Estimates by School Type, by School Type and Sex Cross-Classified, and by School Type and Race Cross-Classified";
Print Percent Sepercent / Style=NCHS;
```

Appendix A

Questionnaire

Questionnaire only included in PDF version of this document.

Appendix B

Student Weight Detail

APPENDIX B. STUDENT WEIGHT DETAIL

Students are selected from schools via the selection of intact class sections as described in Section 2.4.4. The student sampling weight is computed based on a ratio of enrolling to responding students described in Section 4.2.1. 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—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, we omit the subscripts denoting the sampling stages and weight class. The unsubscripted quantities presented are assumed to be within weight class *c*, as defined in section 4.2.1.

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 student weighting class. The initial selection probability is taken to be the inverse of this sampling probability.

In our simplified notation, letting K represent the number of sampled class sections, we have:

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

Nonresponse Adjustment

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

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

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:

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

Simplifying, we get

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

Appendix C

Common Core of Data
Race/Ethnicity Definitions

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.