THE 2002 NATIONAL YOUTH TOBACCO SURVEY: SAMPLING DESIGN AND ESTIMATION ISSUES

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Background of NYTS

The National Youth Tobacco Survey (NYTS) is a national study of middle and high school students sponsored by the American Legacy Foundation and the Centers for Disease Control and Prevention. The anonymous, self-administered questionnaire included questions that asked students about their tobacco use, knowledge and attitudes about smoking, environmental exposure to tobacco smoke and familiarity of pro- and anti-tobacco advertisements. (Farrelly et.al. 2001). A baseline survey was conducted in the fall of 1999 and subsequent surveys were conducted in the spring of 2000 and 2002. Each survey was administered to a nationally representative sample of public and private school students in grades 6 to 12.

Sample Design of NYTS 2000

The NYTS 2000 sample was selected using a multi-stage proportional-to-size (PPS) sample design. The first stage of sample selection involved the selection of the primary sampling units (PSUs). The PSUs were formed from counties or groups of adjacent counties in the 50 states and the District of Columbia. A sample of 148 PSUs was selected by stratified PPS sample selection from the 1,307 PSUs on the sampling frame. Size measures for each PSU were calculated from recent public and private school enrollment data to allow for oversampling of areas with higher concentrations of African American, Asian and Hispanic students. The eight strata used for the PSU selection were formed by the cross of urban/rural classification and four geographical regions (New York, Texas, California and the remainder of the U.S.).

The second stage of sample selection involved the selection of the schools. The 360 schools in the sample were selected using a stratified PPS sampling scheme. The schools were divided into two strata according to size. Large schools were defined as schools that were large enough to support the target sample size of 125 students per school. The small schools were defined as schools that could not meet the target student sample size. In order to reduce the costs associated with implementing the study in small schools which could not produce the desired number of students, the large schools were selected at a much higher sampling rate than the small schools. The size measure for each school was calculated from recent school enrollment data and accounted for the same oversampling of minority racial groups as was done for the PSU size measures. The school sampling frame was sorted within each stratum by the highest eligible grade level in the school, lowest eligible grade level in the school, geographic location and enrollment size for implicit stratification of the school samples. The sorting of the school sampling frame prior to the use of a systematic sample selection rountine ensured sufficient representation in the sample of the middle school and high school grade levels. The number of schools selected for the sample was inflated to account for the assumed school participation rate of 80%.

The third stage of sample selection involved the selection of students within the participating schools. Classes within the schools were selected and every student the selected class was eligible to participate in the survey. The methods of selecting the classes differed according to the way in which the school was organized. The goal of the class selection method was to select approximately five classes in such a way that would minimize the chances of selecting a student more than once and also allow each student to have a chance of being selected. For most schools, this was achieved by selecting classes of a required course, such as English or math, or by selecting classes at a time of day when all students were scheduled for a class.

Sample Design of NYTS 2002 Main Sample

The NYTS 2002 sample design contained two parts: a main sample and a panel sample. Each sample component was designed to be a nationally representative sample of students in grades 6 to 12 in the U.S.

The main sample was selected using a multi-stage PPS sample design that was similar to the design used for the NYTS 2000. The PSUs, counties or groups of adjacent counties, for the NYTS 2002 were constructed in the same manner as the PSUs in the NYTS 2000. A stratified PPS sample of 100 PSUs was selected using 20 strata constructed from five truth^{sm} exposure levels crossed with the four Census Regions (NorthEast, South, MidWest and West). The truth^{sm} exposure was measured using Gross Rating Points (GRPs) for each media market across the U.S. The GRPs were calculated from the media ratings of 12-17 year olds for the television programs during which the truth^{sm} commercials were aired and cumulated over the 2000 calendar year. The truth^{sm} exposure values for the media markets were divided into quintiles for the stratification assignments. Size measures were calculated from recent public and private school enrollment data using the same proportions of oversampling the minority racial groups as was used in the calculation of the NYTS 2000 PSU size measures.

The second stage of sample selection for the main sample involved the selection of the schools. A stratified PPS selection of 215 schools was conducted using the same sampling scheme as the selection of the NYTS 2000 schools. An assumed school participation rate of 80% was used to inflate the sample to ensure a sufficient number of

participating schools.

The third stage of sample selection for the main sample involved the selection of students within the participating schools. The selection of the students followed the same selection process as in NYTS 2000 by determining the best mode of selecting approximately 5 classes based on the school's organization. All students in the selected classes were eligible to participate in the study.

Sample Design of NYTS 2002 Panel Sample

The sample design of the panel sample was developed as a nationally representative subsample of the schools that participated in the NYTS 2000. A stratified systematic sample of 14 schools was selected such that at least one school was selected from within each of the 10 DMAs designated as having the highest levels of truth[sm] exposure. Another stratified systematic sample of 14 schools was selected from the 10 DMAs designated as having the lowest levels of truth[sm] exposure. The remaining DMAs in the U.S. were stratified by truth[sm] exposure quintiles and Census Regions, in the same way that the PSUs for the NYTS 2002 main sample were stratified. A stratified systematic sample of 55 schools was selected from the remainder group of DMAs. Prior to sample selection, the schools within each stratum of the panel sample were sorted by the highest eligible grade level and the lowest eligible grade level in the school to allow for implicit stratification of the sample by middle school and high school grade levels.

Table 1 displays a comparison summary of the sample designs used in the NYTS 2000 and NYTS 2002 studies. Table 2 shows the sample design requirements for the numbers of participating schools and students and the corresponding realized values from each of the study components.

Changes to Sample Designs from 2000 to 2002

The analytical goals of a study must be taken into consideration when constructing a sample design so that the resulting data will have sufficient power to conduct the desired tests. Hence, as the analytical goals of a study change, so should the sample design. For the NYTS 2000, the main analytical goals were to produce state estimates of smoking prevalence for the 3 largest states and to make comparisons on the national estimates of smoking prevalence by race and school type (middle school vs. high school). Based on these analytical goals, the sample design was developed to include stratification of the PSUs by the four geographical regions desired in the analysis and to oversample the less prevalent racial minority groups. Due to difficulties in classifying schools as middle schools or high schools based on different organizations of public and private schools, the sample design included implicit stratification of the school types by sorting the sampling frame by the highest and lowest grade levels present in the schools. For the NYTS 2002, the analytical goals of the study were modified to include comparisons of smoking prevalence by levels of truth[sm] exposure, however state estimates were no longer a high priority. The main analytical goals of the NYTS 2002 also included estimates of smoking prevalence by racial groups and school type, as well as comparisons between NYTS 2000 and NYTS 2002 studies. As a result of the new analytical goals, the NYTS 2002 sample design was modified to include both main and panel sample components and to use truth[sm] exposure as a factor in the construction of first stage strata for PSU selection.

The panel sample component was added to the NYTS 2002 study to evaluate changes in prevalences among the same set of schools over the two-year period. The panel sample also allows before and after prevalence comparisons to be made without biases due to socioeconomic, geographic or other population characteristics.

Adjusting Analysis Weights to Combine Main and Panel Samples in NYTS 2002

The premise of combining the two data sets is that the two sample components are independent samples representing the same population. From a variance minimization perspective (Pedlow and O'Muircheartaigh, 2002), a combined weight may be computed as a linear combination of the two separate weights as follows.

The weighted data file includes the separate weights computed for the two sample components, WTP and WTD, as well as a weight variable for the combined sample. The latter weight was computed separately within each post-stratum, i, as follows for each responding student, j:

$$WT_{ij}\begin{cases} = a_i * WTP_j \text{ if student j is in the panel sample} \\ = (1-a_i) * WTD_j \text{ if student j is in the main sample} \end{cases}$$

The post-stratum cell-specific coefficients, a_i, are proportional to the effective sample size, $n'_i = n_i/DEFF_i$, for each sample component.

We investigated two alternative ways of computing the design effect, $DEFF_i$, for each post-stratum, i, separately for each sample component. One approach considered the DEFF component due to unequal weighting, computed as 1+CV**2 where CV is the coefficient of variation of the weights.

The second approach considered the average DEFF over a set of key survey estimates (prevalence rates) within each post-stratum. This analysis considered the following key survey estimates, the same key estimates considered in the design of the 2002 NYTS sample: prevalence rates for current (30-day) smoking and smoking at least 20 out of the last 30 days, and for being open to smoking.

The choice between the two approaches took into account the variation in estimate-specific DEFF values; if the range in DEFF values were too great within each post-stratum (or for some post-strata), then we would use instead the DEFF component due to unequal weighting. Following the choice of the average DEFF for key estimates, this approach was used for all post-strata, and for the two sample components.

Results

To evaluate how the changes in the NYTS 2002 survey affected the design effects, we examined the design effects associated with the main analytical prevalence rate estimates across the desired analytical domains. For these design effect comparisons, we examined the following prevalence outcomes:

- Smoked on at least one of the past 30 days
- Smoked on at least 20 of the past 30 days
- Susceptibility to smoking, among students who have never smoked

The prevalence outcomes were analyzed with respect to the main demographic student characteristics: gender, race and school type. Table 3 through Table 5 show the sample sizes and design effects incurred for the NYTS 2000 sample, NYTS main and panel samples. In order to due a rudimentary comparison of the effects of the weight adjustment methodology, we also examined the results of using the above mentioned weight adjustment method with a simple weight adjustment method in which the main and panel sample respondents were combined and the weights were prorated by 0.5 to retain the poststratification cell totals.

We were also interested in how the components of the design effects were affected by the changes in the sample designs and the weight adjustment method. Table 6 shows the overall design effects and the design effect components due to stratification and clustering and due to unequal weighting for the prevalence estimates of students who smoked on at least one of the past 30 days.

Conclusions

In the redesign of the sampling design for the NYS 2002, we wanted to include the panel sample results in the analysis of the overall NYTS 2002 findings, but were concerned that the addition of the panel sample component to the analysis would cause unacceptably large design effects. However, the design effects incurred in the NYTS 2002 combined sample using the weight adjustment methods described above were consistently lower than the design effects of the NYTS 2000 for both of the prevalence outcomes related to past 30 day smoking. The design effects for the NYTS 2002 main sample alone were consistently lower than the NYTS 2000 sample for the prevalence estimates of students who smoked on at least one in the past 30 days and were comparable to the NYTS 2000 sample for the outcome of students who smoked at least 20 of the past 30 days. For the prevalence estimates of susceptibility to smoking for students who have never smoked, the design effects for the NYTS 2002 combined sample with adjusted weights and NYTS 2002 main sample were slightly higher than those incurred in the NYTS 2000 study. Upon examination of the design effect components, the design effect due to stratification and clustering were the main contributors to the overall design effect values in each racial group, with the exception of the other/unknown racial category. It appears that the increases in the design effects that we may have incurred by simply combining the NYTS 2002 main and panel samples were canceled out by the variance minimization aspects of the weight adjustment method. The design effects of the NYTS 2002 combined sample follow closely to the NYTS 2002 main sample design effects, with some variation up or down as the panel sample design effects increase or decrease. Where the changes in the NYTS 2002 main sample design resulted in a large reduction in the design effects compared to the NYTS 2000 study, we did not incur reductions in analytical power by combining the panel sample with the main sample.

References

Farrelly, M. et. al. (2001). Legacy First Look Report 7. Cigarette Smoking Among Youth: Results from the 2000 National Youth Tobacco Survey. Washington, DC: American Legacy Foundation.

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Table 1. Summary Comparison of NYTS 2000 and 2002 Sample Designs

	NYTS 2000	NYTS 2002 Main	NYTS 2002 Panel
1st Stage	148 PSUs 8 Strata Urban/Rural x Regions (NY, TX, CA & Remainder U.S.)	100 PSUs 20 Strata truth[sm] Quintiles x Census Regions (NE, S, MW, W)	83 Schools 24 Strata 10 Highest DMAs 10 Lowest DMAs 14 truth[sm] x Census Region strata
2nd Stage	360 Schools 2 Strata Large (≥125 Students) & Small (< 125 Students)	215 Schools 2 Strata Large (≥125 Students) & Small (< 125 Students	approx. 5 Classes Every student in selected classes was eligible to participate
3rd Stage	approx. 5 Classes Every student in selected classes was eligible to participate	approx. 5 Classes Every student in selected classes was eligible to participate	

Table 2. Comparison of Response Rates and Sample Sizes

	NYTS 2000 Sample	NYTS 2002 Main Sample	NYTS 2002 Panel Sample	NYTS 2002 Overall
Design Sample Size				
Schools	270	140	60	200
Students	25,760	175,000	7,500	25,000
Respondents				
Schools	324	177	69	246
Students	35,828	18,467	7,682	26,149
Response Rates				
Schools	90%	83%	84%	83%
Students	93%			91%
Overall	84%			75%

Table 3. Sample Sizes and Design Effects for Smoked at least One of the Past 30 Days

	NYTS 2000 Sample	NYTS 2002 Combined Adjusted Weight	NYTS 2002 Combined Simple Weight	NYTS 2002 Main Sample	NYTS 2002 Panel Sample
GENDER	34,658	25,914	25,914	18,302	7,612
Total	12.1	8.0	11.7	7.8	10.6
Male	7.2	4.9	6.5	4.9	5.6
Female	7.0	5.6	8.2	4.9	7.6
RACE	34,670	25,963	25,963	18,338	7,625
Total	12.2	7.9	11.6	7.7	10.5
Black	5.2	3.2	8.4	2.9	8.4
Hispanic	3.6	1.8	2.3	1.8	1.9
White	11.6	7.3	10.0	7.1	9.0
Other/ Unknown	1.9	1.8	1.7	2.0	1.2
SCHOOL TYPE	34,579	25,963	25,963	18,338	7,625
Total	12.1	7.9	11.6	7.7	10.5
Middle School	6.7	4.6	5.4	5.4	4.0
High School	7.4	5.4	6.0	7.4	4.0

Table 4. Sample Sizes and Design Effects for Smoked at least 20 Days in the Past 30 Days

	NYTS 2000 Sample	NYTS 2002 Combined Adjusted Weight	NYTS 2002 Combined Simple Weight	NYTS 2002 Main Sample	NYTS 2002 Panel Sample
GENDER	34,658	25,914	25,914	18,302	7,612
Total	9.9	9.3	12.2	9.9	10.5
Male	5.3	5.5	6.3	6.6	4.8
Female	6.5	7.1	9.3	6.2	8.5
RACE	34,670	25,963	25,963	18,338	7,625
Total	9.9	9.1	12.1	9.7	10.5
Black	3.6	2.7	7.4	2.1	7.3
Hispanic	2.2	1.9	1.8	2.1	1.3
White	8.1	7.7	9.2	8.4	7.5
Other/ Unknown	2.2	1.9	2.3	1.9	2.2
SCHOOL TYPE	34,579	25,963	25,963	18,338	7,625
Total	9.9	9.1	12.1	9.7	10.5
Middle School	3.9	4.3	4.2	5.2	2.5
High School	7.0	6.7	8.7	7.9	7.0

Table 5. Sample Sizes and Design Effects for Susceptibility to Smoking, among Students who Have Never Smoked

	NYTS 2000 Sample	NYTS 2002 Combined Adjusted Weight	NYTS 2002 Combined Simple Weight	NYTS 2002 Main Sample	NYTS 2002 Panel Sample
GENDER	17,168	13,779	13,779	9,901	3,878
Total	3.0	3.3	4.3	4.0	3.4
Male	2.0	2.3	2.8	2.6	2.2
Female	2.1	2.2	2.9	2.4	2.4
RACE	17,171	13,799	13,799	9,916	3,883
Total	3.0	3.4	4.4	4.1	3.4
Black	1.5	1.6	1.6	1.7	1.2
Hispanic	1.0	1.4	1.6	1.7	1.2
White	3.5	3.6	4.6	4.2	3.5
Other/ Unknown	1.4	1.8	2.8	1.5	2.1
SCHOOL TYPE	17,152	13,799	13,799	9,916	3,883
Total	3.0	3.4	4.4	4.1	3.4
Middle School	2.7	2.8	3.3	3.2	2.6
High School	2.6	3.6	4.9	4.4	3.9

Table 6. Sample Sizes and Design Effect Components for:Smoked at Least One out of the Past 30 Days

		NYTS 2000	NYTS 2002 Combined Sample	NYTS 2002 Combined Simple Weight	NYTS 2002 Drawn Sample	NYTS 2002 Panel Sample
RACE		34,670	25,963	25,963	18,338	7,625
Total	Overall DEFF	12.2	7.9	11.6	7.7	10.5
	DEFF due to strat/cluster	9.1	5.0	6.2	4.9	6.9
	DEFF due to unequal wts	1.3	1.6	1.9	1.6	1.5
Black	Overall DEFF	5.2	3.2	8.4	2.9	8.4
	DEFF due to strat/cluster	4.2	2.7	5.4	2.8	6.1
	DEFF due to unequal wts	1.3	1.6	2.0	1.5	1.4
Hispanic	Overall DEFF	3.6	1.8	2.3	1.8	1.9
	DEFF due to strat/cluster	4.8	2.1	2.2	2.1	2.1
	DEFF due to unequal wts	1.3	1.5	1.9	1.5	1.6
White	Overall DEFF	11.6	7.3	10.0	7.1	9.0
	DEFF due to strat/cluster	7.7	4.0	4.8	3.8	5.3
	DEFF due to unequal wts	1.3	1.4	1.6	1.3	1.5
Other/ Unknown	Overall DEFF	1.9	1.8	1.7	2.0	1.2
	DEFF due to strat/cluster	2.1	1.4	1.0	1.7	0.8
	DEFF due to unequal wts	1.4	1.8	2.3	1.8	1.6