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Evaluating Nonresponse Bias in the 2018-2019 Tobacco Use Supplement to the Current Population Survey

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Table of Contents

Tables

1. Executive Summary

This report presents the results of analyses of various nonresponse estimates computed for the 2018-2019 Tobacco Use Supplement (TUS) to the Current Population Survey (CPS). The sample included all persons who completed a CPS interview and remained eligible for the TUS after CPS editing. A nonresponse bias analysis was conducted to determine whether nonresponse among different demographic groups may have biased estimates. We investigated overall response rates, demographic subgroup response rates, and demographic respondent and nonrespondent distributions for the TUS-restricted self-response weights. We fitted a logistic model to the response indicator to identify the household level and respondent demographic characteristics correlated with the TUS self-eligible nonresponse. In the last step, we compared the estimates produced using the nonresponse adjusted weights with those produced using weights without the response adjustments.

Our key findings for the 2018-2019 TUS are:

- The weighted response rate for the TUS persons selected to respond to the additional self-response questions was 54.47 percent.

- Based on statistically significant differences alone, there is evidence of potential nonresponse bias for self-respondents for the following investigated characteristics: principal city status, Census region, urban/rural status, race, sex, Hispanic origin (ethnicity), age, measure of labor force, educational attainment, number of persons selected for self-response questions (based on the count of civilians, aged 18 or older in the household), panel (month in sample), and CPS data collection mode.

- The largest difference in response rates is seen in the number of persons eligible for self-response questions in the household. Persons in households with only one TUS self-response eligible civilian adults aged 18 or older (within household sampling rate=1) had the highest response rates. Persons in households with five or more TUS eligible civilian adults aged 18 or older had the lowest response rate. Age groups had the second largest response rate differences, with the youngest group having the lowest response rate compared to other age groups. While this describes the largest and smallest differences, most, if not all differences are not substantive.

- The *chi*-square tests for responses between the respondent and nonrespondent distributions for all investigated characteristics showed statistically significant differences (at the confidence level $\alpha = 0.05$) except for type of living quarters. Age groups and the number of persons selected for self-response questions had very large *chi*-square statistics; yet even for these differences, the largest for any given subcategory was 3-4 percentage points, and most were under one percentage point.

- The *t*-tests for the differences in distributions produced by the TUS intermediate weight and the TUS final weight (adjusted for nonresponse) show significant differences in the analyzed characteristics. These results suggest that adults in households with one civilian aged 18 or older or who completed the CPS in CATI are overrepresented in the TUS final weight file. However, these differences produce bias if adults in households with one civilian aged 18 or older or who completed the CPS in CATI have different tobacco use.

- Most CPS household and person-level characteristics (except for type of household) explain nonresponse. The interaction between age groups and categories of the number of eligible TUS self-response adults in the household is significant. Households with younger and fewer members tend to respond at a lower rate than those older adults in households with a larger number of TUS self-eligible adults.

- Although the confidence intervals of tobacco use estimates computed using TUS self-response weights with and without nonresponse adjustments overlapped, the *t*-tests showed that the differences between these estimates were statistically significant. This result supports the use of nonresponse-adjusted weights for computing TUS estimates.

2. Introduction

The Office of Management and Budget (OMB) provides guidelines for conducting a nonresponse bias Analysis (NRBA) when the unit response rate of a survey is below 80 percent (OMB, 2006). The overall supplement response rate is 54.47 percent, computed as the TUS person self-response among those adults who had completed the CPS interview and met other eligibility criteria is below this threshold, indicating a need for this analysis.

This document provides the results of the NRBA with the evaluation of nonresponse in the 2018-2019 TUS to the CPS. Its purpose is to determine the existence of potential nonresponse bias in the 2018-2019 TUS.

3. Overview of the Current Population Survey

The monthly CPS collects primarily labor force data about the civilian noninstitutionalized population living in the United States. The institutionalized population, which is excluded from the population universe, is composed primarily of the population in correctional institutions and nursing homes, with the latter being 98 percent of the 4.0 million institutionalized people based on the 2010 Census.

In the CPS, interviewers ask questions concerning the labor force participation of each member 15 years old and older in sample households. For the July 2018, January 2019, and May 2019 CPS, the week containing the nineteenth of the month is the interview week, and the week containing the twelfth is the reference week (e.g., the week about which the labor force questions are asked).

The CPS uses a multistage probability sample design based on the decennial census results, covering all 50 states and the District of Columbia. The Census Bureau gradually introduces a new CPS sample after the most recent decennial census data became available. The sample is continually updated between censuses to account for new residential construction.

The CPS first-stage sample is redesigned every ten years, reflecting changes from the most recent decennial census.[1] Primary sampling units (PSUs)[2] are created and sampled in the first stage of the sampling process. In the 2010 sample design, the United States was divided into 1,987 PSUs. These PSUs were then grouped into 852 strata before sampling. A single PSU was selected within each stratum with a probability of selection proportional to its population as of the most recent decennial census. PSUs were chosen with certainty in strata consisting of only one PSU.

4. Overview of the 2018-2019 Tobacco Use Supplement to the Current Population Survey

The CPS, sponsored jointly by the Census Bureau and the US Bureau of Labor Statistics, is the country's primary source of labor force statistics for the US population. The National Cancer Institute (NCI) of the National Institutes of Health (NIH) and the US Food and Drug Administration's Center for Tobacco Products (FDA-CTP), both from the Department of Health and Human Services (DHHS), co-sponsored the supplemental questions for the July 2018, January 2019, and May 2019 TUS. NCI has sponsored the supplemental questions for the TUS since 1992.

In July 2018, January 2019, and May 2019, in addition to the basic CPS questions, interviewers asked supplementary questions about tobacco use of the civilian non-institutionalized population 18 years and older. This information is used to gather reliable data to measure changes in America's use of

[1] For detailed information on the 2010 sample redesign, please see Bureau of Labor Statistics (April 2014).
[2] The PSUs correspond to geographically contiguous substate areas (i.e., counties or groups of counties).

tobacco products, social norms, and policies, as well as to understand public attitudes towards smoking.

The key tobacco use estimates produced using the TUS supplemental data include the following:

- Number and percentage of current smokers, former smokers, and those who have never smoked cigarettes;
- Percentage of smokers who have attempted to quit and who intend to quit;
- Number of cigarettes smoked per day for current smokers;
- Cost for cigarettes and purchase locations;
- Extent of advice to quit smoking;
- Existence of workplace and home smoking restrictions;
- Attitudes toward smoke-free policies in public places; and
- A limited set of questions on other tobacco product use.

The key domains for these estimates are

- Households,
- Families,
- Persons, and
- Age groups.

5. Efforts for Reducing Nonresponse in the 2018-2019 Tobacco Use Supplement to the Current Population Survey

Some degree of nonresponse bias is a normal feature of almost all population surveys. Because tobacco use estimates are produced from the TUS data from responding households and persons, these estimates are biased if the answers from respondents differ from those potential answers from nonrespondents. The magnitude of the bias is a function of the response rate and the differences in tobacco use between respondents and nonrespondents.

When the CPS respondents did not respond to the TUS interview after being randomly selected for self-interview, they became nonrespondents to the TUS. The households/persons that did not respond to CPS were considered ineligible to TUS, and the CPS nonresponse weighting adjustment accounted for them.

The TUS is directly linked to the CPS response, and both CPS and TUS attempt to minimize nonresponse bias by increasing response rates while reducing potential differences between respondents and nonrespondents and adjusting the weights for nonresponse.

The CPS response rate was increased by conducting personal visit interviews for new and returning sample units within CPS, mailing advance letters for all sample units, providing a Spanish language questionnaire for respondents who do not speak English, allowing interpreters for respondents who do not speak English or Spanish, training field representatives to gain respondent cooperation, and recontacting the household via an in-person visit to nonresponding households. TUS allowed proxy respondents to increase the response rate in special circumstances.

Reducing respondent burden for the TUS supplemental questions also helped to increase the response rate. In the TUS 2018/19 data cycle, the respondent burden was minimized in two ways: 1) limiting the average interview length per household to ten minutes, and 2) implementing a random selection process, where only certain TUS-eligible persons within each household were required to self-respond to the TUS questionnaire. All TUS eligible adults in households with one or two were selected. Two and three adults were sampled in households with three or four eligible adults and households with more than 4 eligible adults, respectively.

Noninterview weighting adjustments were made to account for the nonrespondents' characteristics, thus reducing potential nonresponse bias. These adjustments identified groups of respondents and nonrespondents with an assumed similar likelihood to respond. These groups are called nonresponse adjustment cells, and the weights are adjusted by reallocating the weights of nonrespondents into the respondents within the cell.

The CPS nonresponse adjustments accounted for households and persons who did not respond to the CPS. For the 2018/19 data cycle, the CPS noninterview adjustment cells were formed using noninterview clusters (NICL) and the PSU central city status. The NICLs were created by grouping sample PSUs with similar metropolitan status (e.g., metropolitan or not metropolitan PSU) and

population size within the same state (US Census Bureau, 2019). Metropolitan PSUs were further classified into "central city" and "not central city" within a state. This classification resulted in 127 NICLs and 214 adjustment cells. In this adjustment, the NICL and PSU central city status were used to create the noninterview adjustment cells because they were thought to be correlated with the CPS variables of interest.

The TUS nonresponse adjustment accounted for the TUS noninterviews using the same CPS noninterview nonresponse adjustment cells. While proxies for the selected self-respondents may respond for them after four callback attempts to reach them, for this analysis of self-response rate, the TUS proxy respondents were classified as nonrespondents.

Despite the efforts taken to reduce nonresponse bias, it is still likely that some nonresponse bias cannot be corrected without knowing the tobacco use of the nonrespondents.

6. Methods

We refer to the analysis for identifying nonresponse bias as "Restricted Self-Response Weights Analysis," In this analysis, estimates for the TUS persons selected for self-response questions were produced using two sets of weights. This section describes the source of data, weights, population universe, and definition of respondents and nonrespondents.

Data

There are three sets of data sources for the Restricted Self-Response Weights Analysis. The first set includes the monthly data files for the public use of TUS/CPS for July 2018, January 2019, and May 2019.[3] These files contain all CPS respondents with the CPS items available for all respondents. The file also includes the TUS tobacco use items available only for TUS respondents. The file contains the variables to identify the response status of TUS self-response persons (see next section for the definition of eligible respondents and eligible nonrespondents). The files contain the CPS final full

[3] The July 2018 CPS-TUS public use data file (JUL18PUB.DAT), were downloaded from https://www.census.gov/data/datasets/time-series/demo/cps/cps-supp_cps-repwgt/cps-tobacco.2018.html#list-tab-1125220621). The January and May 2019 CPS public use data files (JAN19PUB.DAT and MAY19PUB.DAT), the corresponding files with the replicate weights (files JAN19SRREP.DAT and MAY1SRREP.DAT) and were downloaded from https://www.census.gov/data/datasets/time-series/demo/cps/cps-supp_cps-repwgt/cps-tobacco.2019.html#list-tab-1125220621.

sample weight (PWSSWGT) and TUS- self-response final weight (PWSRWGT). The second source included the public use TUS- self-response final replicate weight files for July 2018, January 2019, and May 2019.[4] The third source included the files with replicate weights for the CPS respondents for the three months provided by NCI.[5]

Respondent Definition

In the Restricted Self-Response Weights Analysis, a respondent status (SELFRESP) is only defined for self-response sampled persons in the TUS universe (see TUS universe definition at Current Population Survey, May 2019, Tobacco Use Supplement Technical Documentation). A TUS respondent meets the following conditions:

A. Person was an adult civilian household member (PRPERTYP=2),

B. Persons aged 18 years old or older (PRTAGE ≥ 18),

C. Person was selected for the TUS interview (PEELGFLG=1),

D. Person was self-respondent for the supplement (PRS64=1), and

E. Person completed the interview (INTRVIEW=1).

TUS self-response nonrespondents are those who met conditions A, B, and C, and either of the two conditions:

F. The respondent is a proxy of the sampled person (PRS64=2)

G. Did not complete the interview (INTRVIEW =2).

[4] The CPS-TUS supplement public use file for July 2018 with the replicate weights (JUL18SRREP.DAT) were downloaded from https://www.census.gov/data/datasets/time-series/demo/cps/cps-supp_cps-repwgt/cps-tobacco.2018.html#list-tab-1125220621). The CPS-TUS supplement public use file for January and May 2019 with the replicate weights (JAN19PUB.DAT and MAY19PUB.DAT) with the replicate weights (JAN19SRREP.DAT and MAY1SRREP.DAT) were downloaded from https://www.census.gov/data/datasets/time-series/demo/cps/cps-supp_cps-repwgt/cps-tobacco.2019.html#list-tab-1125220621.

[5] The files with the CPS final replicate weights for July 2018, January and May 2019 (SSRP0718_PU, FLS.SSRP0119_PU, and SSRP0519_PU contained the CPS replicate weights PWSSWGT0 to PWSSWGT160.

Weights

Two sets of weights are used in this analysis. The first set includes the TUS intermediate weights (HHFWGT0 to HHFWGT160) for July 2018, January 2019, and May 2019. The TUS intermediate weights were created using the final CPS monthly weights (PWSSWGT0 to PWSSWGT160) adjusted for TUS self-response subsampling. As mentioned in Section 5, TUS eligible respondents in the household were subsampled for the TUS interview. The TUS intermediate weights were created by adjusting the CPS monthly weights by the subsampling factor based on the number of TUS self-response eligible adults in the household. The subsampling adjustment factor for households with one or two TUS eligible adults was 1. For households with three or four eligible adults, the adjustment factor was computed as the number of eligible adults divided by 2. For households with five or more eligible adults, the adjustment factor was computed as the number of eligible adults divided by 3. Because this analysis used a combined file of three months of data and each file represents the eligible US population, the TUS intermediate weights in the combined file were adjusted by dividing the weights by three, so the sum of weights still represented the TUS eligible US population.

The second set of weights is the final TUS self-response weight for July 2018, January 2019, and May 2019. The final TUS weights were also divided by three in the combined file, so the sum of weights represented the eligible US population. This set of weights incorporated nonresponse adjustment and multi-step benchmarking to the Census population. For more details, see US Census Bureau (2019).

Table 1 summarizes the number of cases and the sums of weights for the combined July 2018, January 2019, and May 2019 by TUS self-response status. The analysis uses 238,680 TUS self-response adults with 137,455 respondents. The estimate of the total TUS eligible population in the US based on the TUS self-response intermediate weight is 238,031,579. The same estimate using the TUS self-response final weight is 249,979,293, 5 percent higher than the TUS self-response intermediate estimate. The weighted overall response rate is 54.47 percent.

Table 1 Number of cases and Sums of Weights for the combined July 2018, January 2019, and May 2019 files by TUS self-response disposition code for TUS self-response intermediate weight (HHFWGT0) and TUS self-response final weight (PWSRWGT0)*.

TUS self-response disposition code (SELFRESP)	Sample size	Sum of TUS self-response intermediate weights (HHFWGT0)	Sum of TUS self-response final weight (PWSRWGT0)
Respondent	137,455	129,648,395	249,979,293
Nonrespondent	101,225	108,383,184	0
Total	**238,680**	**238,031,579**	**249,979,293**

* Includes only TUS respondents and nonrespondents

Respondent Characteristics

The Restricted Self-Response Weights Analysis focuses on identifying person-level nonresponse bias for the selected person demographics, housing unit characteristics, and geography. The geographic, household, and person characteristics and their levels investigated in the analyses are

- Type of Living Quarters: Housing Units and Non-Housing units;[6]
- Principal City Status: Principal City within Core-Based Statistical Area/Metropolitan Statistical Area (CBSA/MSA), Not Part of a Principal City within CBSA/MSA, and Outside of a CBSA/MSA;
- Census Region: Northeast, Midwest, South, and West;
- Urban/Rural Status: Urban, Rural, and Missing;
- Race: White Only, Black Only, Asian Only, Other Race/Two or More Races;
- Sex: Male, Female;
- Hispanic Origin: Hispanic, Non-Hispanic;
- Age group: 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, and 75 years old or older;
- Measure of Labor Force (labor force status): Employed, Unemployed, Not in the Labor Force;

[6] Non-HUs include quarters within rooming or boarding homes; non-permanent units in transient hotels, motels, etc.; unoccupied sites for mobile homes, trailers, or tents; group quarters in school dormitories; and other units that are not defined to be housing units.

- Educational Attainment: Less than High School (HS.) Diploma; HS Diploma; Some college, no degree; Associate's Degree; Bachelor's Degree; Master's Degree; Doctorate or Professional Degree;

- Categories of the number of TUS self-response eligible persons in the household: 1 (One TUS self-response eligible civilian aged 18 years old or older), 2 (Two TUS self-response eligible civilians 18 years or older), 3 (Three to four TUS self-response eligible civilians 18 years old or older), and 4 (Five or more TUS self-response eligible civilians 18 years or older);

- Panel: Month in Sample with values 1 to 8; and

- CPS Survey Interview mode: Computer-assisted telephone interviewing (CATI) and computer-assisted personal interviews (CAPI).

All numbers presented in the report are weighted unless otherwise noted.

7. Limitations

Some limitations in the Restricted Self-Response Weights Analysis may affect the findings. Firstly, the absence of the intermediate TUS weights after within household sampling and before nonresponse weighting adjustments means we had to derive this set of weights based on available public use file information and desired within household sampling plans, which may not precisely match Census Bureau's internal weights. Secondly, the intermediate set of weights after nonresponse adjustment and before poststratification or raking is unavailable. We utilize the final TUS weights for self-response, incorporating post-stratification/raking, as post-nonresponse adjustment weights. Thirdly, defining Respondent/Nonrespondent status is based on final public use file information, potentially differing from Census Bureau's definition. For example, there were 16 eligible records with Interview flag PEELGFLG=4, indicating they were not selected for interview so they should be excluded from the nonresponse adjustment process, but they received positive final TUS self-response weights. Lastly, TUS respondents' characteristics are conditional on CPS respondents' characteristics since CPS nonrespondents are not eligible to participate in the TUS. But these limitations might not significantly impact analysis results.

8. Response Rates

In the first analysis, we computed the TUS self-response rates as the proportion of eligible sample cases who responded to both the CPS and the TUS to the total sampled cases for both surveys.[7] The analysis compares weighted and unweighted response rates by domains to identify potential biases.

The response rate is computed as

$$RR = \frac{\sum_{i \in s} w_i R_i D_i}{\sum_{i \in s} w_i D_i}$$

where

w_i is the appropriate weight (1 if unweighted) for the response rate calculation;

R_i is the response indicator (1 for respondents, 0 for nonrespondents);

D_i is the domain indicator (1 if within the domain of interest, 0 otherwise); and

s is the set of all eligible households or persons in the key domain computed.

The CPS interview data contains all TUS eligible and non-eligible persons in sampled housing units. In contrast, the TUS interview data contains only TUS-eligible persons within eligible CPS housing units. The TUS eligible household units are those without Type B or Type C (out of scope) outcome codes. Individual persons within group quarters are treated as individual housing units.

The analysis compares the 2018-2019 TUS self-response weighted and unweighted response rates by person, household, and geographic characteristics listed above.

[7] CPS Nonresponding households may have a different number of persons than interviewed ones, so combining household- and person-level rates may lead to an over/underestimate of the true overall nonresponse rate and under/overestimate of the true overall response rate for persons for the Tobacco Use supplement. Thus, TUS response rates are expressed as the ratio of the persons who responded to the TUS among those eligible to respond (adults with complete CPS interviews) and in some cases in larger households also randomly selected for self-response among all those eligible in the household.

9. Restricted Self-Response Weights Analysis

The first part of the Restricted Self-Response Weights Analysis includes persons selected for the TUS self-response questions using the TUS intermediate weights by response status (See Section 6 for TUS self-response intermediate weight and respondent and nonrespondent definitions).

Response Rates

Table 2 shows the weighted response rates and the standard error for all TUS persons selected for self-response questions by the characteristics described above for the combined July 2018, January 2019, and May 2019 data. The response rates were computed using the TUS intermediate weight described in Section 6. The standard errors in the table were computed using the TUS replicate intermediate weights, which account for the sample design. The standard errors are conditional on the CPS respondent sample and show variability in the response process rather than the traditional sampling error.

Table 2 Tobacco Use Survey Response Rates[a] for Combined July 2018, January 2019, and May 2019 Data.

Characteristic	Unweighted Persons*	Weighted Persons*	Weighted Response Rate (%)	Standard Error (%)	P-Value
Overall	238,680	238,031,579	54.47	0.1961	-
Type of Living Quarters					
Housing Unit	238,535	237,896,449	54.46	0.1963	0.39473
Non-Housing Unit	145	135,130	58.94	5.3715	
Principal City Status					
Principal City within CBSA/MSAC	57,362	66,363,456	55.42	0.2837	
Not Part of a Principal City within CBSA/MSAC	91,719	107,696,529	52.77	0.2212	<0.0001
Outside of a CBSA/MSAC	47,031	30,741,795	57.55	0.8317	
Not Identified	42,568	33,229,798	55.23	0.6953	
Region					
Northeast	39,489	41,933,709	51.79	0.4547	
Midwest	47,643	49,889,660	55.88	0.5289	<0.0001
South	88,304	89,936,591	55.23	0.2925	
West	63,244	56,271,620	53.98	0.3170	
Urban/Rural Status					
Urban	189,311	205,455,370	53.96	0.1937	
Rural	47,031	30,741,795	57.55	0.8317	<0.0001
Missing	2,338	1,834,414	59.59	2.4416	
Race					
White Only	195,839	185,788,089	55.21	0.2233	
Black Only	23,615	29,532,449	53.80	0.4265	<0.0001
Asian Only	11,758	14,572,700	48.41	0.5733	
Other Race/Two or More Races	7,468	8,138,341	50.87	0.6752	

Characteristic	Unweighted Persons*	Weighted Persons*	Weighted Response Rate (%)	Standard Error (%)	P-Value
Sex					
Male	112,948	114,822,404	52.23	0.2459	<0.0001
Female	125,732	123,209,174	56.55	0.2282	
Ethnicity					
Hispanic	28,364	39,008,566	49.45	0.3876	<0.0001
Non-Hispanic	210,316	199,023,012	55.45	0.2062	
Age Group					
18-24 years old	19,650	27,366,646	35.22	0.4198	
25-34 years old	38,955	42,447,852	52.22	0.3515	
35-44 years old	40,021	39,047,204	54.39	0.3480	
45-54 years old	37,484	39,149,958	54.27	0.3633	<0.0001
55-64 years old	43,293	40,367,229	58.68	0.3060	
65-74 years old	35,235	29,539,034	64.01	0.3185	
75 years old or older	24,042	20,113,655	63.46	0.4489	
Labor force status					
Employed	145,074	148,650,158	53.19	0.2154	
Unemployed	5,379	5,945,267	56.18	0.9429	<0.0001
Not in Labor Force	88,227	83,436,154	56.63	0.2512	
Educational Attainment					
Less than High School Diploma	21,996	24,368,656	48.67	0.4434	<0.0001
High School Diploma	68,936	68,324,662	50.16	0.3190	
Some College, No Degree	41,781	42,776,226	54.19	0.3438	
Associate's Degree	24,778	23,782,812	58.10	0.4073	
Bachelor's Degree	51,091	50,540,253	57.90	0.3076	
Master's Degree	22,109	20,917,273	61.54	0.4290	
Doctorate or Professional Degree	7,989	7,321,697	59.87	0.6417	
Number of eligible TUS self-response adults in the household					
1 civilian aged 18 or older	48,968	41,969,270	81.12	0.2458	<0.0001
2 civilians aged 18 or older	144,390	124,300,825	54.63	0.2123	
3 to 4 civilians aged 18 or older	40,577	63,091,356	39.96	0.3486	
5 or more civilians aged 18 or older	4,745	8,670,128	28.68	0.9253	
Panel (Month in Sample)					
1	28,651	29,625,724	60.53	0.4527	<0.0001
2	29,658	29,840,413	54.98	0.4133	
3	30,064	29,846,866	53.66	0.4093	
4	30,574	30,017,608	53.95	0.3992	
5	29,416	29,830,399	55.27	0.4017	
6	30,035	29,750,128	52.45	0.4292	
7	29,877	29,637,830	52.20	0.4242	
8	30,405	29,482,612	52.70	0.3911	
CPS Interview Mode					
CATI	21,794	20,128,048	68.31	0.4074	<0.0001
CAPI	216,886	217,903,531	53.19	0.2125	

Source: US Census Bureau, Current Population Survey data files for July 1018, January 2019, and May 2019.
[a] Restricted to only persons selected for the TUS self-response questions.
* May not sum to totals due to rounding. For the weighted percentage of the total sample, see Table 3.
** Weighted by the TUS Intermediate Weights (see Section 6)

The last column of the table shows the *p*-values of the ANOVA *F*-statistics of the hypothesis tests for differences in response rates among the subgroups. The table shows that the differences are significant, with *p*-values less than 0.0001 for all characteristics except for type of living quarters.

The two lowest response rates are for persons in households with five or more TUS eligible civilians (28.68 percent), followed by persons 18 to 24 years old (35.22 percent). The largest response rates are for persons in households with one TUS civilian 18 years old eligible for self-response questions (81.12 percent), followed by persons who completed the interview in CATI (68.31 percent).

The table shows some expected results for this type of population survey. The CAPI-CATI results are not surprising. Those who completed the CPS interview in CATI (calls made from a telephone Center by other dedicated interviewers) responded at a higher rate (about 15 percentage points) than those who completed the CPS in CAPI. Also, as expected, adults in households with few TUS self-response eligible adults, females, non-Hispanics, older people, and those with higher educational attainment responded at higher rates. In contrast, males, younger adults, Hispanics, and those with lower educational attainment were less likely to respond. Even though there are significant differences between the respondents and nonrespondents, the differences might not be large enough to cause meaningful differences in the TUS estimates.

Furthermore, weighting adjustments might also minimize the impact of some differences. However, the practical significance of response rate differences is usually driven more by the magnitude of the difference. Therefore, the number of household members selected for self-response questions and age have the most potential for bias for these restricted self-respondent groups.

Respondent Distributions

The next analysis evaluated the effectiveness of the TUS final weights (which were adjusted for TUS self-response, nonresponse, and potential population under coverage by a set of key socio-demographic variables) in reducing the bias of estimates of person and household characteristics. The bias is reduced when the TUS intermediate and final weight produce the same distributions for characteristics related to tobacco use.

We compared the TUS self-response sample distributions using the TUS intermediate and final weights. The TUS intermediate weight distribution was computed using TUS respondents and nonrespondents, while the TUS final weight distribution only included respondents. The results are summarized in Table 3.

The first and second columns of the panel with the sample distribution in the table show the sample size in percentages in the TUS intermediate and final weight files, respectively. In the panel with the weighted distribution, the first column shows the estimates of the distribution of the TUS self-response eligible persons using the TUS intermediate weight. In contrast, the second column shows the distribution using the final TUS weight for TUS self-selected respondents.

The table shows the chi-square statistics and the *p*-values of the hypothesis tests of differences between the distributions produced using the TUS intermediate and final weights. The chi-square tests show no statistical differences at the 0.01 significant level between the distributions estimated by the two weights for type of living quarters, sex, and Hispanic origin. However, the differences are statistically significant for the remaining characteristics.

Notice that the chi-square tests only indicate that the distributions in the two sets of weights differ but do not necessarily indicate an important difference or a nonresponse bias problem. These differences only cause bias if the respondents and nonrespondents report differing rates of tobacco use, the main outcomes that TUS focuses on.

The next column to the last in the table shows the *p*-values of the *t*-test, comparing the percentages produced by the two weights for each category. The last column indicates the significance of the *t*-test after applying the Bonferroni adjustment for multiple comparisons. The table shows large differences between the distributions, which match the magnitude of the chi-square test statistics. The largest percentage difference is for adults in households with one eligible TUS self-response adults aged 18 or older with 7.74 percentage points (17.63 percent using the TUS intermediate weight vs. 25.37 percent using the TUS final weight). In contrast, the difference between the percentages of adults in households with 3 and 4 eligible TUS self-response adults aged 18 or older is -5.6 percentage points. These results show that adults in households with one or two eligible TUS adults aged 18 or older are overrepresented. In contrast, those in households with 3 and 4 eligible adults are underrepresented in the TUS final weight file. However, as mentioned before, these differences produce bias if, for example, adults in these households have different tobacco use.

Table 3 Tobacco Use Respondent and Nonrespondent Distributions for Combined July 2018, January 2019, and May 2019 Analysis

Characteristic	TUS Sample Size Distribution		TUS Weighted Sample Size Distribution		Chi-Square Statistic	P-value	P-Value for T-Test	Bonferroni Significance
	All (%)*	Respondents (%)	Intermediate weight (%)	Final Weight (%)				
Type of Living Quarters								
Housing Unit	99.94	99.93	99.94	99.94	0.197	0.6570	<0.0001	*
Non-Housing Unit	0.06	0.07	0.06	0.06			<0.0001	*
Principal City Status								
Principal City within CBSA/MSAC	24.03	24.69	27.88	29.15	92.977	<0.0001	<0.0001	*
Not Part of a Principal City within CBSA/MSAC	38.43	37.16	45.24	44.71			0.0004	
Outside of a CBSA/MSAC	19.70	20.28	12.92	12.41			<0.0001	*
Not Identified	17.83	17.87	13.96	13.74			0.0568	*
Region								
Northeast	16.54	15.94	17.62	17.53	48.719	<0.0001	0.0220	*
Midwest	19.96	20.18	20.96	20.71			<0.0001	*
South	37.00	37.40	37.78	37.93			0.0037	*
West	26.50	26.48	23.64	23.83			0.0001	*
Urban/Rural Status								
Urban	79.32	78.67	86.31	86.83	41.896	<0.0001	<0.0001	*
Rural	19.70	20.28	12.92	12.41			<0.0001	*
Missing	0.98	1.05	0.77	0.76			0.4638	
Race								
White only	82.05	82.78	78.05	77.73	24.407	<0.0001	<0.0001	*
Black only	9.89	9.93	12.41	12.66			<0.0001	*
Asian only	4.93	4.35	6.12	6.22			0.0146	*
Other race/Two or more races	3.13	2.94	3.42	3.40			0.4876	
Sex								
Male	47.32	45.46	48.24	48.19	0.475	0.4909	0.4919	
Female	52.68	54.54	51.76	51.81			0.4919	
Hispanic Origin								
Hispanic	11.88	10.84	16.39	16.51	6.424	0.0113	0.0122	*
Non-Hispanic	88.12	89.16	83.61	83.49			0.0122	*
Age Groups								
18-24 years old	8.23	5.55	11.50	11.82	56.585	<0.0001	<0.0001	*
25-34 years old	16.32	15.72	17.83	17.88			0.3240	
35-44 years old	16.77	16.32	16.40	16.29			0.0063	*
45-54 years old	15.70	15.24	16.45	16.34			0.0227	*
55-64 years old	18.14	18.94	16.96	16.87			0.0415	*
65-74 years old	14.76	16.76	12.41	12.37			0.2960	
75 years old or older	10.07	11.46	8.45	8.42			0.3452	
Measure of Labor Force								
Employed	60.78	58.92	62.45	62.94	77.611	<0.0001	<0.0001	*
Unemployed	2.25	2.34	2.50	2.81			<0.0001	*
Not in Labor Force	36.96	38.74	35.05	34.25			<0.0001	*

Characteristic	TUS Sample Size Distribution		TUS Weighted Sample Size Distribution		Chi-Square Statistic	P-value	P-Value for T-Test	Bonferroni Significance
	All (%)*	Respondents (%)	Intermediate weight (%)	Final Weight (%)				
Educational Attainment								
Less than High School Diploma	9.22	8.45	10.24	9.54	585.084	<0.0001	<0.0001	*
High School Diploma	28.88	26.64	28.70	26.50			<0.0001	*
Some College, No Degree	17.51	17.80	17.97	18.37			0.0002	*
Associate's Degree	10.38	10.85	9.99	10.38			<0.0001	*
Bachelor's Degree	21.41	22.45	21.23	22.41			<0.0001	*
Master's Degree	9.26	10.22	8.79	9.56			<0.0001	*
Doctorate or Professional Degree	3.35	3.59	3.08	3.24			<0.0001	*
Number of Eligible TUS self-response Adults in the Household								
1 civilian aged 18 or older	20.52	29.03	17.63	25.37	2,366.352	<0.0001	<0.0001	*
2 civilians aged 18 or older	60.50	57.81	52.22	51.55			<0.0001	*
3 to 4 civilians aged 18 or older	17.00	12.14	26.51	20.91			<0.0001	*
5 or more civilians aged 18 or older	1.99	1.02	3.64	2.17			<0.0001	*
Panel (Month in Sample)								
1	12.00	13.27	12.45	13.04	96.842	<0.0001	<0.0001	*
2	12.43	12.58	12.54	12.84			0.0010	*
3	12.60	12.42	12.54	12.72			0.0221	*
4	12.81	12.68	12.61	12.75			0.0402	*
5	12.32	12.38	12.53	12.02			<0.0001	*
6	12.58	12.17	12.50	12.14			<0.0001	*
7	12.52	12.10	12.45	12.27			0.0250	*
8	12.74	12.40	12.39	12.20			0.0090	*
CPS Interview Mode								
CATI	9.13	11.37	8.46	10.59	697.620	<0.0001	<0.0001	*
CAPI	90.87	88.63	91.54	89.41			<0.0001	*

Source: US Census Bureau, Current Population Survey data files for July 2018, January 2019, and May 2019.
* May not sum to totals due to rounding.

In the next part of the Restricted Self-Response Weights Analysis, we performed a propensity score regression analysis on the TUS self-response indicator to identify the significant variables related to the likelihood of responding. We fitted a weighted logistic regression model with the following categorical explanatory variables: groups for the number of eligible TUS self-response adults in the household, principal city status, Census region, urban/rural status, race, sex, Hispanic origin, age groups, measure of labor force, educational attainment groups, panel, mode, and the interaction between age groups and groups for the number of household members selected for self-response. The model was fitted to the combined July 2018, January 2019, and May 2019 TUS self-response intermediate weight files.

The results of the analysis are summarized in Tables 4 and 5. Table 4 shows the Maximum Likelihood estimates and the *F*-statistics with their *p*-values of the joint test that all the parameters associated with that effect are zero. Table 5 provides the point estimates and 95% confidence intervals of the odds ratios of the fitted model for selected odd ratios.[8]

Table 4 Analysis of Maximum Likelihood Estimates and Joint Tests for Propensity Score Logistic Regression on TUS Self-Response Indicator*

Parameter/level	Estimate	Standard Error	t Value	Pr > |t|	F Value	Pr > F
Intercept	-0.140	0.0693	-2.02	0.0455		
Group for the number of eligible TUS self-response adults in the household					328.90	<.0001
1 civilian aged 18 or older	1.812	0.0682	26.57	<.0001		
2 civilians aged 18 or older	0.729	0.0584	12.47	<.0001		
3 to 4 civilians aged 18 or older	—	—	—	—		
5 or more civilians aged 18 or older	-0.792	0.1990	-3.98	0.0001		
Principal City Status					6.38	0.0004
Principal City within CBSA/MSAC	—	—	—	—		
Not Part of a Principal City within CBSA/MSAC	-0.058	0.0155	-3.75	0.0002		
Outside of a CBSA/MSAC	0.057	0.0380	1.51	0.1322		
Not Identified	-0.020	0.0317	-0.64	0.5224		
Census Region					11.68	<.0001
Northeast	-0.127	0.0231	-5.48	<.0001		
Midwest	-0.024	0.0265	-0.89	0.3738		
South	-0.013	0.0183	-0.73	0.4636		
West	—	—	—	—		
Race					21.56	<.0001
White Only	—	—	—	—		
Black Only	-0.124	0.0202	-6.12	<.0001		

[8] The table containing 378 odd ratios for the interaction between the groups for number of eligible TUS self-response adults in the household and the age groups are provided in the Supplemental Material (NRBA Supplemental Material 5-3-2024.xlsx).

Parameter/level	Estimate	Standard Error	t Value	Pr > |t|	F Value	Pr > F
Asian Only	-0.142	0.0240	-5.93	<.0001		
Other Race/Two or More Races	-0.047	0.0300	-1.55	0.1222		
Sex					71.97	<.0001
Male	-0.099	0.0117	-8.48	<.0001		
Female	—	—	—	—		
Ethnicity					8.33	0.0044
Hispanic	0.049	0.0169	2.89	0.0044		
Non-Hispanic	—	—	—	—		
Age Groups					179.25	<.0001
18-24 years old	-0.576	0.0652	-8.83	<.0001		
25-34 years old	-0.322	0.0656	-4.91	<.0001		
35-44 years old	0.099	0.0650	1.52	0.1310		
45-54 years old	0.238	0.0640	3.73	0.0003		
55-64 years old	0.371	0.0692	5.35	<.0001		
65-74 years old	0.403	0.0724	5.56	<.0001		
75 years old or older	—	—	—	—		
Labor Force					31.54	<.0001
Employed	—	—	—	—		
Unemployed	0.309	0.0390	7.91	<.0001		
Not in Labor Force	0.003	0.0133	0.24	0.8128		
Education attainment					113.55	<.0001
Less than High School Diploma	-0.316	0.0324	-9.75	<.0001		
High School Diploma	-0.280	0.0309	-9.06	<.0001		
Some College, No Degree	-0.034	0.0318	-1.08	0.2810		
Associate's Degree	-0.008	0.0306	-0.25	0.8050		
Bachelor's Degree	0.010	0.0292	0.36	0.7219		
Master's Degree	0.087	0.0332	2.63	0.0093		
Doctorate or Professional Degree	—	—	—	—		
Interaction between groups of the number of eligible TUS self-response adults in the household and Age Groups					29.52	<.0001
1 civilian aged 18 or older * 18-24 years old	0.687	0.1013	6.78	<.0001		
1 civilian aged 18 or older * 25-34 years old	0.229	0.0844	2.71	0.0075		
1 civilian aged 18 or older * 35-44 years old	-0.226	0.0805	-2.80	0.0057		
1 civilian aged 18 or older * 45-54 years old	-0.359	0.0872	-4.12	<.0001		
1 civilian aged 18 or older * 55-64 years old	-0.263	0.0851	-3.09	0.0023		
1 civilian aged 18 or older * 65-74 years old	-0.175	0.0842	-2.08	0.0392		
1 civilian aged 18 or older * 75 years old or older	—	—	—	—		
2 civilians aged 18 or older * 18-24 years old	-0.023	0.0718	-0.33	0.7451		
2 civilians aged 18 or older * 25-34 years old	0.066	0.0646	1.03	0.3055		
2 civilians aged 18 or older * 35-44 years old	-0.357	0.0621	-5.76	<.0001		
2 civilians aged 18 or older * 45-54 years old	-0.511	0.0651	-7.85	<.0001		
2 civilians aged 18 or older * 55-64 years old	-0.510	0.0679	-7.51	<.0001		
2 civilians aged 18 or older * 65-74 years old	-0.361	0.0731	-4.93	<.0001		
2 civilians aged 18 or older * 75 years old or older	—	—	—	—		

Parameter/level	Estimate	Standard Error	t Value	Pr > |t|	F Value	Pr > F
3 to 4 civilians aged 18 or older * 18-24 years old	—	—	—	—		
3 to 4 civilians aged 18 or older * 25-34 years old	—	—	—	—		
3 to 4 civilians aged 18 or older * 35-44 years old	—	—	—	—		
3 to 4 civilians aged 18 or older * 45-54 years old	—	—	—	—		
3 to 4 civilians aged 18 or older * 55-64 years old	—	—	—	—		
3 to 4 civilians aged 18 or older * 65-74 years old	—	—	—	—		
3 to 4 civilians aged 18 or older * 75 years old or older	—	—	—	—		
5 or more civilians aged 18 or older * 18-24 years old	0.414	0.2115	1.96	0.0522		
5 or more civilians aged 18 or older * 25-34 years old	0.352	0.2204	1.60	0.1124		
5 or more civilians aged 18 or older * 35-44 years old	0.024	0.2284	0.11	0.9164		
5 or more civilians aged 18 or older * 45-54 years old	0.610	0.2142	2.85	0.0050		
5 or more civilians aged 18 or older * 55-64 years old	0.512	0.2135	2.40	0.0177		
5 or more civilians aged 18 or older * 65-74 years old	0.135	0.2471	0.55	0.5843		
5 or more civilians aged 18 or older * 75 years old or older	—	—	—	—		

* Urban/rural status was originally included in the model but was removed because it is highly correlated with principal city status.

Source: US Census Bureau, Current Population Survey data files for July 2018, January 2019, and May 2019.

Table 5 Selected Odds Ratios for Propensity Score Regression Analysis on the TUS Self-Response Indicator*

Effect	Point Estimate	95% Confidence Limits	
Principal City Status			
(2) Not Part of a Principal City within CBSA/MSAC vs. (1) Principal City within CBSA/MSAC	**0.944**	**0.915**	**0.973**
(3) Outside of a CBSA/MSAC vs. (1) Principal City within CBSA/MSAC	1.059	0.983	1.142
(4) Not Identified vs. (1) Principal City within CBSA/MSAC	0.980	0.920	1.043
Region			
(1) Northeast vs. (4) West	**0.881**	**0.842**	**0.922**
(2) Midwest vs. (4) West	0.977	0.927	1.029
(3) South vs. (4) West	0.987	0.952	1.023
Race			
(2) Black Only vs. (1) White Only	**0.884**	**0.849**	**0.920**
(3) Asian Only vs. (1) White Only	**0.867**	**0.827**	**0.909**
(4) Other Race/Two or More Races vs. (1) White Only	0.954	0.899	1.013
Sex			
(1) Male vs. (2) Female	**0.905**	**0.885**	**0.927**
Hispanic Origin			
(1) Non-Hispanic vs. (2) Hispanic	**1.050**	**1.015**	**1.085**
Labor force status			
(2) Unemployed vs. (1) Employed	**1.362**	**1.261**	**1.471**
(3) Not in Labor Force vs. (1) Employed	1.003	0.977	1.030
Educational Attainment			
(1) Less than High School Diploma vs. (7) Doctorate or Professional Degree	**0.729**	**0.684**	**0.777**
(2) High School Diploma vs. (7) Doctorate or Professional Degree	**0.756**	**0.711**	**0.804**
(3) Some College, No Degree vs. (7) Doctorate or Professional Degree	0.966	0.907	1.029
(4) Associate's Degree vs. (7) Doctorate or Professional Degree	0.992	0.934	1.054
(5) Bachelor's Degree vs. (7) Doctorate or Professional Degree	1.010	0.954	1.070
(6) Master's Degree vs. (7) Doctorate or Professional Degree	**1.091**	**1.022**	**1.165**

* Urban/rural status was originally included in the model but was removed because it is highly correlated with principal city status; Significant odds ratios at alpha=0.05 are bolded.

Source: US Census Bureau, Current Population Survey data files for July 2018, January 2019, and May 2019.

The results in Table 4 show that most person and household characteristics explain the TUS self-response nonresponse. The number of eligible TUS self-response adults in the household members and the interaction with age are significant.

Even though there are significantly different distributions between the respondents and nonrespondents, the differences might not be large enough to cause meaningful differences in estimates from the two groups. Many of the significant testing results may be due to the large sample size of TUS. Furthermore, weighting adjustments might also minimize the impact of some

differences. Because the CPS and TUS noninterview adjustments account for NICL and central city status, region, principal city status, and urban/rural status differences may have been reduced with those adjustments.

The two most important effects of exposure for nonresponse in Table 5 are unemployed TUS-self-response adults, who were 1.40 more likely to respond than those not in the labor force, and adults with less than a high school diploma who were 0.73 less likely to respond than those with a doctorate or professional degree. The latter result is common in population surveys where adults with lower education attainment respond at a lower rate than those with higher attainment. Other important effects to respond include those for the interactions between groups of the number of eligible TUS self-response adults in the household and age groups found in the supplemental material. For example, adults in households with one eligible TUS self-response civilian 18 years old or older are much more likely to respond than those in households with more than one TUS self-response civilian 18 years old or older, independently of the sampled person's age (e.g., an average odd ratio of 7.0 for these interactions). On the other hand, respondents in groups 65-64 and 74 years or older are, on average, 4.0 times more likely to respond than those in the younger age groups, independent of the number of TUS self-response eligible civilian adults in the household.

In the last part of the Restricted Self-Response Weights Analysis, we modeled the TUS collected outcomes using the TUS self-response intermediate weight and final weights. The goal of the analysis is to compare the TUS estimates produced using weights with and without nonresponse adjustments. The outcome tobacco use variables in this analysis are current smokers, current e-cigarette users, current cigar users, and current menthol preferences among current cigarette smokers. The results are summarized in Table 6, which shows estimates, standard errors, and 95 percent confidence intervals of the proportion for the selected tobacco use characteristics for estimates computed using the self-response intermediate weights and self-response final weights. The table also shows the estimates of the difference between these estimates, standard errors, and 95 percent confidence intervals. The last column is the p-values of the t–test for the statistical difference between the proportions computed using the two weights. The t–test takes into account the high correlation between the estimates because the difference estimates are computed using the

same respondents (with the same CPS data and TUS response) but with different weights.[9] Note that although the confidence intervals of the estimates overlap, the difference is statistically significant at the 0.01 level when the correlation is accounted for.

[9] The estimates produced using weights with and without nonresponse adjustments are highly correlated because they are based on the same respondents with the same CPS data and TUS responses. That is, the only difference are the weights used to compute the estimates. To account for the correlation between the estimates produced using these two weights, an analysis file is created by appending the file of respondents with the weights without the nonresponse adjustment and the similar file with the weights with the nonresponse adjustment aligning the full sample and replicate weights. When appending these files an indicator is created to identify the source of the cases in the analysis file (i.e., respondents with weights with and without nonresponse adjustment). Then the difference and the standard errors between the estimates using with and without nonresponse adjustments is computed using standard survey software using the source indicator (e.g., PROC SURVEYMEANS with the statement DOMAIN and option DIFFMEANS). This procedure account for the high correlation in the standard errors for the difference between the estimates produce using the different sets of weights.

Table 6 TUS Tobacco Use estimates computed using TUS Self-Response Intermediate and Nonresponse Adjusted Weights.

Tobacco Us Item	Self-Response Intermediate Weight			Self-Response Final Weight			Difference			
	Estimate (%)	Standard Error (%)	95% confidence Interval	Estimate (%)	Standard Error (%)	95% confidence Interval	Estimate (%)	Standard Error (%)	95% confidence Interval	P-value
Current Smoker	11.663	0.116	(11.434, 11.892)	11.410	0.114	(11.184, 11.635)	0.253	0.041	(0.252, 0.254)	<.0001
Current e-cigarette user	2.102	0.052	(1.999, 2.205)	2.304	0.058	(2.188, 2.419)	-0.202	0.022	(-0.202, -0.202)	<.0001
Current cigar user	2.002	0.048	(1.908, 2.096)	2.068	0.051	(1.966, 2.17)	-0.066	0.017	(-0.066, -0.065)	0.0002
Current menthol preference among current cigarette smokers	31.898	0.404	(31.1, 32.696)	32.347	0.434	(31.49, 33.204)	-0.449	0.166	(-0.452, -0.446)	0.0076

Source: US Census Bureau, Current Population Survey data files for July 2018, January 2019, and May 2019.

10. Discussion and Conclusions

This analysis found potential factors that could lead to nonresponse bias for TUS self-respondents, including principal city status, region, urban/rural status, race, sex, Hispanic origin, age groups, measure of labor force, educational attainment, and number of eligible TUS self-response adults in the household. However, although many of these factors showed significant differences between respondents and nonrespondents, the magnitudes of some of the differences are not substantial. It is essential to recognize that small differences can be statistically significant because of the large survey sample size of the CPS and TUS. These differences only cause bias if the respondents and nonrespondents report differing results for the tobacco use outcomes of interest. Nonetheless, very large *chi*-square statistics and the largest difference in response rates were seen in the adults by the number of TUS self-response eligible persons in the household, with the highest response rate for those adults in households with only one TUS self-response eligible aged 18 or older. Age groups had the second-largest difference in response rate in the analyses. The youngest age group, 18-24, is less likely to respond compared to other age groups.

While the propensity regression analysis suggests that using such an adjustment based on the statistically significant variables used in the model might be somewhat beneficial, the self-response nonresponse final weight computed by the Census Bureau for 2018-19 TUS did not use such variables in for the nonresponse weighting adjustment. The Census Bureau implemented its standard weighting process using the same nonresponse adjustment weighting cells used in the CPS. However, the Census Bureau will use a propensity regression adjustment similar to that examined in Tables 4 and 5 for future waves of TUS.

For future studies, additional/improved data collection efforts may be applied to the younger age group and households for adults older than the youngest age group(s) with 5 or more eligible adults to increase response rates from those groups. Including all the significant factors identified in this report, the nonresponse adjustment weighting will minimize potential nonresponse bias.

11. References

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