American Community Survey
Selected Population Tables and
American Indian and Alaska Native Tables
Accuracy of the Data (2015)

INTRODUCTION

The data contained in the Selected Population Tables (SPT) and American Indian and Alaska Native Tables (AIANT) data products are based on the American Community Survey (ACS) sample interviewed from January 1, 2011 through December 31, 2015. The ACS data replaced the Census long-form data, which historically produced demographic, housing and socio-economic estimates for the nation as part of the once-a-decade census. The 2015 SPT data products contain estimates for over four hundred highly detailed race, Hispanic origin, ancestry and tribal groups down to the Census tract geographic level. The 2015 AIANT products are available for about 1,400 American Indian and Alaska Native groups. Fewer geographic types are available for these data products than in the regular 2011-2015 5-year ACS data products, however Alaska Native Regional Corporations and American Indian and Alaska Native Areas and Hawaiian Home lands are included.

The 2011-2015 5-year ACS data products are another source of published estimates of race, Hispanic origin, ancestry and tribal groups.

These products were last produced in 2012, using the 2006-2010 5-year ACS data. Prior to that, the Census 2000 Summary File 4 (SF4) data products were published shortly after the 2000 Census. While similarities exist between the Census 2000 SF4 data products and the ACS SPT and AIANT data products, they are not the same due to changes in methodology and the layouts of the estimates in the data products. In particular, the Census 2000 used the long-form data to create the SF4 data products, which was a 1-in-6 sample of the housing units, or roughly 19 million housing units. In contrast, the 2011-2015 ACS 5-year data are from a sample of roughly 15 million housing units. In addition, while the Census data may be considered a point estimate, the ACS data are 5-year period estimates and should be interpreted as estimates that describe a 5-year time period.

The ACS sample is selected from all counties and county-equivalents in the United States. In 2006, the ACS began collection of data from a sample of residents of in group quarters (GQs) – for example, military barracks, college dormitories, nursing homes, and correctional facilities. Residents of group quarters are included with persons in housing units (HUs) in all SPT and AIANT estimates that are based on the total population.

The ACS, like any other statistical activity, is subject to error. The purpose of this documentation is to provide data users with a basic understanding of the ACS sample design, estimation methodology, and accuracy of the SPT and AIANT data. The ACS is sponsored by the U.S. Census Bureau, and is part of the 2020 Decennial Census Program.

Additional information on the design and methodology of the ACS, including data collection and processing, can be found at: https://www.census.gov/programs-surveys/acs/technical-documentation.html

TABLE OF CONTENTS

DATA COLLECTION

The ACS currently employs four modes of data collection:

- Internet
- Mailout/Mailback
- Computer Assisted Telephone Interview (CATI)
- Computer Assisted Personal Interview (CAPI)

The ACS has been using the mailout/mailback, CATI, and CAPI modes since the survey's inception in 2005; it started using the Internet mode in 2013.

With the exception of addresses in Remote Alaska, the general timing of data collection is:

Month 1: Prior to 2013, addresses that were determined to be mailable were sent questionnaires via the U.S. Postal Service. This included a second questionnaire, in case a sample address had not responded within approximately three weeks after having received the initial questionnaire.

From 2013 onward, addresses in sample that are determined to be mailable are sent an initial mailing package – this package contains information for completing the ACS questionnaire on the internet (on-line). If, after two weeks, a sample address has not responded on-line, then it is sent a second mailing package. This package contains a paper questionnaire. Once the second package is received, sampled addresses then have the option of which mode to use for filling out the questionnaire.

Month 2: All mail non-responding addresses with an available phone number are sent to CATI.

Month 3: A sample of mail non-responses without a phone number, CATI non-responses, and unmailable addresses are selected and sent to CAPI.

Note that mail responses are accepted during all three months of data collection.

All Remote Alaska addresses that are in sample are assigned to one of two data collection periods, January-April, or September-December and are all sent to the CAPI mode of data collection.[1] Data for these addresses are collected using CAPI only and up to four months are allowed to complete the interviews in Remote Alaska for each data collection period.

[1] Prior to the 2011 sample year, all remote Alaska sample cases were subsampled for CAPI at a rate of 2-in-3.

SAMPLE DESIGN

Sampling rates are assigned independently at the census tabulation block level. A measure of size is calculated for each of the following active, functioning governmental units:

- Counties
- Places
- School Districts (elementary, secondary, and unified)
- American Indian Areas
- Tribal Subdivisions
- Alaska Native Village Statistical Areas
- Hawaiian Homelands
- Minor Civil Divisions – in Connecticut, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Wisconsin (these are the states where MCDs are active, functioning governmental units)
- Census Designated Places – in Hawaii only

The measure of size for all areas except American Indian Areas, Tribal Subdivisions, Alaska Native Village Statistical Areas, and Hawaiian Homelands is an estimate of the number of occupied HUs in the area. This is calculated by multiplying the number of ACS addresses by an estimated occupancy rate at the block level. A measure of size for each Census Tract is also calculated in the same manner.

For American Indian, Tribal Subdivisions, and Alaska Native Village Statistical Areas, the measure of size is the estimated number of occupied HUs multiplied by the proportion of people reporting American Indian or Alaska Native (alone or in combination). Prior to 2011, this was calculated using Census 2000 occupancy and response data. Beginning in 2011, the ACS uses occupancy and response data from the 2010 Census.

For Hawaiian Homelands, the measure of size is the estimated number of occupied HUs multiplied by the proportion of people reporting Native Hawaiian (alone or in combination) in the 2010 Census.

Each block is then assigned the smallest measure of size from the set of all entities of which it is a part. The sampling rates for 2011, 2012, 2013, 2014 and 2015 are shown in Table 1 below. Beginning in 2011 the ACS implemented a sample reallocation as well as a sample increase. The sample reallocation increased the number of second-stage sampling strata from seven to 16. The sample increase changed the target annual sample size from 2.9 million to 3.54 million addresses annually.

Table 1. 2011 through 2015 Sampling Rates for the United States

Stratum Thresholds	2011 Percent In Sample	2012 Sampling Rates	2013 Sampling Rates	2014 Sampling Rates	2015 Sampling Rates
0 < MOS[1] ≤ 200	14.81%	15.00%	15.00%	15.00%	15.00%
200 < MOS ≤ 400	9.94%	10.00%	10.00%	10.00%	10.00%
400 < MOS ≤ 800	6.97%	7.00%	7.00%	7.00%	7.00%
800 < MOS < 1,200	4.44%	4.40%	4.40%	4.37%	4.35%
0 < TRACTMOS[2] ≤ 400	5.55%	5.55%	5.55%	5.47%	5.44%
0 < TRACTMOS ≤ 400 H.R.[3]	5.00%	5.06%	5.06%	5.03%	5.00%
400 < TRACTMOS ≤ 1,000	4.46%	4.40%	4.40%	4.37%	4.35%
400 < TRACTMOS ≤ 1,000 H.R.	4.10%	4.04%	4.04%	4.02%	4.00%
1,000 < TRACTMOS ≤ 2,000	2.71%	2.67%	2.67%	2.66%	2.64%
1,000 < TRACTMOS ≤ 2,000 H.R.	2.49%	2.46%	2.46%	2.44%	2.43%
2,000 < TRACTMOS ≤ 4,000	1.61%	1.57%	1.57%	1.56%	1.55%
2,000 < TRACTMOS ≤ 4,000 H.R.	1.47%	1.44%	1.44%	1.44%	1.43%
4,000 < TRACTMOS ≤ 6,000	0.96%	0.94%	0.94%	0.94%	0.93%
4,000 < TRACTMOS ≤ 6,000 H.R.	0.89%	0.87%	0.87%	0.86%	0.86%
6,000 < TRACTMOS	0.57%	0.55%	0.55%	0.55%	0.54%
6,000 < TRACTMOS H.R.	0.53%	0.51%	0.51%	0.50%	0.50%

[1]MOS = Measure of size of the smallest governmental entity

[2]TRACTMOS = Census Tract measure of size.

[3]H.R. = areas where predicted levels of completed mail and CATI interviews are > 60%.

Prior to 2011, all addresses determined to be unmailable were subsampled for the CAPI phase of data collection at a rate of 2-in-3. All other sample addresses that did not respond to the mail or CATI modes of data collections were subsampled for CAPI at a rate of 1-in-2, 2-in-5 or 2-in-3.

Unmailable addresses, which include Remote Alaska addresses, do not go to the CATI phase of data collection. Beginning in 2011, at the same time as the sample increase, there was a change in how addresses were selected for CAPI. Table 2 shows the new CAPI sampling rates that were implemented in 2011 (midway through the year).

Table 2. Second-Phase (CAPI) Subsampling Rates for the United States

Address and Tract Characteristics	CAPI Subsampling Rate
Addresses in Remote Alaska[1]	Take all (100%)
Addresses in Hawaiian Homelands, Alaska Native Village Statistical areas and a subset of American Indian areas[1]	Take all (100%)
Unmailable addresses that are not in the previous two categories	66.7%
Mailable addresses in tracts with predicted levels of completed mail and CATI interviews prior to CAPI subsampling between 0% and less than 36%	50.0%
Mailable addresses in tracts with predicted levels of completed mail and CATI interviews prior to CAPI subsampling greater than 35% and less than 51%	40.0%
Mailable addresses in other tracts	33.3%

[1]The full CAPI follow-up procedure for these two categories began in 2011.

For a more detailed description of the ACS sampling methodology, see the 2015 ACS Accuracy of the Data document at:
https://www.census.gov/programs-surveys/acs/technical-documentation/code-lists.html.

For more information relating to sampling in a specific year, please refer to the individual year's Accuracy of the Data document at:
https://www.census.gov/programs-surveys/acs/technical-documentation/code-lists.html

WEIGHTING METHODOLOGY

The data provided on the SPT and the AIANT are multiyear estimates that should be interpreted as estimates that describe a time period rather than a specific reference year. For example, a SPT estimate for the poverty rate of a given area describes the total set of people who lived in that area over those five years where as a 1-year estimate for the same characteristic describes the set of people who lived in that area over one year. The only fundamental difference between the estimates is the number of months of collected data that are considered in forming the estimate. For this reason, the estimation procedure used for all multiyear estimates (2011-2015 5-year, SPT, and AIANT estimates) is an extension of the 2015 single year estimation procedure. In this document, only the procedures that are unique to all multiyear estimates are discussed below.

To weight the 5-year, SPT, or AIANT estimates, 60 months of collected data are pooled together. The pooled data are then reweighted using the procedures developed for the 2015 single year estimates with a few adjustments. These adjustments concern geography, month-specific weighting steps, and population and housing unit controls. In addition to these adjustments, there is one multiyear specific model-assisted weighting step.

Some of the weighting steps use the month of tabulation in forming the weighting cells within which the weighting adjustments are made. One such example is the non-interview adjustment. In these weighting steps, the month of tabulation is used independently of year. Thus, for the 5-year, SPT, and AIANT, sample cases from May 2011, May 2012, May 2013, May 2014, and May 2015 are combined into one weighting cell.

Since the multiyear estimates represent estimates for the period, the controls are not a single year's housing or population estimates from the Population Estimates Program, but rather are an average of these estimates over the period. For the housing unit controls, a simple average of the single housing unit estimates over the period is calculated for each county or subcounty area. The version or vintage of estimates used is always the last year of the period since these are considered to be the most up-to-date and are created using a consistent methodology. For example, the housing unit control used for a given county in the 2011-2015 weighting is equal to the simple average of the 2011, 2012, 2013, 2014, and 2015 estimates that were produced using the 2010 methodology (the 2010 vintage). Likewise, the population controls by race, ethnicity, age, and sex are obtained by taking a simple average of the single year population estimates of the county or weighting area by race, ethnicity, age, and sex. For example, the 2011-2015 control total used for Hispanic males age 20-24 in a given county would be obtained by averaging the single year population estimates for that demographic group for 2011, 2012, 2013, 2014, and 2015. The version or vintage of estimates used is always that of the last year of the period since these are considered to be the most up to date and are created using a consistent methodology.

One multiyear specific step is a model-assisted (generalized regression or GREG) weighting step. The objective of this additional step is to reduce the variances of base demographics at the tract level in the 2011-2015 ACS 5-year estimates, SPT estimates, and AIANT estimates. While reducing the variances, the estimates themselves are relatively unchanged. This process involves linking administrative record data with ACS data.

In addition, a finite population correction (FPC) factor is included in the creation of the replicate weights for the 2011-2015 ACS 5-year, SPT, and AIANT data at the tract level. It reduces the estimate of the variance and the margin of error by taking the sampling rate into account. A two-tiered approach was used. One FPC was calculated for mail and CATI respondents and another for CAPI respondents. The CAPI was given a separate FPC to take into account the fact that CAPI respondents are subsampled. The FPC is not included in the single year data because the sampling rates are relatively small and thus the FPC does not have an appreciable impact on the variance.

For more information on the replicate weights and replicate factors, see the Design and Methodology Report located at:
https://www.census.gov/programs-surveys/acs/methodology/design-and-methodology.html

ESTIMATION METHODOLOGY FOR MULTIYEAR ESTIMATES

For the single year estimation, the tabulation geography for the data is based on the boundaries defined on January 1 of the tabulation year, which is consistent with the tabulation geography used to produce the population estimates. All sample addresses are updated with this geography prior to weighting. For the multiyear estimation, the tabulation geography for the data is referenced to the final year in the multiyear period. For example, the 2011-2015 period uses the 2015 reference geography. Thus, all data collected over the period of 2011-2015 in the blocks that are contained in the 2015 boundaries for a given place are tabulated as though they were a part of that place for the entire period.

Monetary values for the 2011-2015 ACS 5-year, SPT, and AIANT estimates are inflation adjusted to the final year of the period. For example, the 2011-2015 ACS 5-year estimates are tabulated using 2015 adjusted dollars. These adjustments use the national Consumer Price Index (CPI) since a regional-based CPI is not available for the entire country.

For a more detailed description of the ACS estimation methodology, see the 2015 Accuracy of the Data document at:

https://www.census.gov/programs-surveys/acs/technical-documentation/code-lists.html

For more information relating to estimation in a specific year, please refer to the individual year's Accuracy of the Data document at:
https://www.census.gov/programs-surveys/acs/technical-documentation/code-lists.html

CONFIDENTIALITY OF THE DATA

The Census Bureau has modified or suppressed some data on this site to protect confidentiality. Title 13 United States Code, Section 9, prohibits the Census Bureau from publishing results in which an individual's data can be identified.

The Census Bureau's internal Disclosure Review Board sets the confidentiality rules for all data releases. A checklist approach is used to ensure that all potential risks to the confidentiality of the data are considered and addressed.

- Title 13, United States Code: Title 13 of the United States Code authorizes the Census Bureau to conduct censuses and surveys. Section 9 of the same Title requires that any information collected from the public under the authority of Title 13 be maintained as confidential. Section 214 of Title 13 and Sections 3559 and 3571 of Title 18 of the United States Code provide for the imposition of penalties of up to five years in prison and up to $250,000 in fines for wrongful disclosure of confidential census information.

- Minimum Population Threshold: A detailed race, Hispanic origin, ancestry, or tribal group is required to have a minimum population of 7,000 at the national level to be eligible for data products to be produced for SPT data products. For the AIANT data, the population threshold is 100. This is to ensure data quality as well as protect data confidentiality. The population count of 7,000 and 100 were based upon 2010 Census data for race, Hispanic origin, and tribal groups. However, ancestry was not a question on the 2010 Census. Therefore, the 2011-2015 5-year ACS data were initially used to determine if an ancestry group should be included. If an ancestry group did not meet the threshold using the 5-year ACS data, but was published for Census 2000, it was included as being eligible for production. The 5-year ACS is a smaller sample than the 2000 long-form data. As such, an ancestry group may not have made the threshold in 2015, simply due to the smaller sample size. Estimates are published for an individual group in a particular geography if it had at least 50 unweighted sample cases. This threshold applies to both the SPT and AIANT data. Table 3 summarizes the population threshold data below.

Table 3: Minimum Population Thresholds for Production and Release

Description	Population Threshold	
	SPT Populations	AIANT Populations
Minimum threshold level for a group to be included in production	7,000	100
Minimum threshold for releasing to the public (unweighted cases)	50	50

- Disclosure Limitation: Disclosure limitation is the process for protecting the confidentiality of data. A disclosure of data occurs when someone can use published statistical information to identify an individual that has provided information under a pledge of confidentiality. For data tabulations, the Census Bureau uses disclosure limitation procedures to modify or remove the characteristics that put confidential information at risk for disclosure. Although it may appear that a table shows information about a specific individual, the Census Bureau has taken steps to disguise or suppress the original data while making sure the results are still useful. The techniques used by the Census Bureau to protect confidentiality in tabulations vary, depending on the type of data.

- Data Swapping: Data swapping is a method of disclosure limitation designed to protect confidentiality in tables of frequency data (the number or percent of the population with certain characteristics). Data swapping is done by editing the source data or exchanging records for a sample of cases when creating a table. A sample of households is selected and matched on a set of selected key variables with households in neighboring geographic areas that have similar characteristics (such as the same number of adults and same number of children). Because the swap often occurs within a neighboring area, there is no effect on the marginal totals for the area or for totals that include data from multiple areas. Because of data swapping, users should not assume that tables with cells having a value of one or two reveal information about specific individuals. Data swapping procedures were first used in the 1990 Census, and were used again in Census 2000 and the 2010 Census.

ERRORS IN THE DATA

- Sampling Error — The data in the ACS products are estimates of the actual figures that would have been obtained by interviewing the entire population using the same methodology. The estimates from the chosen sample also differ from other samples of housing units and persons within those housing units. Sampling error in data arises due to the use of probability sampling, which is necessary to ensure the integrity and representativeness of sample survey results. The implementation of statistical sampling procedures provides the basis for the statistical analysis of sample data. Measures used to estimate the sampling error are provided in the next section.

- Nonsampling Error — In addition to sampling error, data users should realize that other types of errors may be introduced during any of the various complex operations used to collect and process survey data. For example, operations such as data entry from questionnaires and editing may introduce error into the estimates. Another source is through the use of controls in the weighting. The controls are designed to mitigate the effects of systematic undercoverage of certain groups who are difficult to enumerate as well as to reduce the variance. The controls are based on the population estimates extrapolated from the previous census. Errors can be brought into the data if the extrapolation methods do not properly reflect the population. However, the potential risk from using the controls in the weighting process is offset by far greater benefits to the ACS estimates. These benefits include reducing the effects of a larger coverage problem found in most surveys, including the ACS, and the reduction of standard errors of ACS estimates. These and other sources of error contribute to the nonsampling error component of the total error of survey estimates. Nonsampling errors may affect the data in two ways. Errors that are introduced randomly increase the variability of the data. Systematic errors which are consistent in one direction introduce bias into the results of a sample survey. The Census Bureau protects against the effect of systematic errors on survey estimates by conducting extensive research and evaluation programs on sampling techniques, questionnaire design, and data collection and processing procedures. In addition, an important goal of the ACS is to minimize the amount of nonsampling error introduced through nonresponse for sample housing units. One way of accomplishing this is by following up on mail nonrespondents during the CATI and CAPI phases. For more information, please see the section entitled "Control of Nonsampling Error".

MEASURES OF SAMPLING ERROR

Sampling error is the difference between an estimate based on a sample and the corresponding value that would be obtained if the estimate were based on the entire population (as from a census). Note that sample-based estimates will vary depending on the particular sample selected from the population. Measures of the magnitude of sampling error reflect the variation in the estimates over all possible samples that could have been selected from the population using the same sampling methodology.

Estimates of the magnitude of sampling errors – in the form of margins of error – are provided with all published ACS data. The Census Bureau recommends that data users incorporate this information into their analyses, as sampling error in survey estimates could impact the conclusions drawn from the results.

Confidence Intervals and Margins of Error

Confidence Intervals – A sample estimate and its estimated standard error may be used to construct confidence intervals about the estimate. These intervals are ranges that will contain the average value of the estimated characteristic that results over all possible samples, with a known probability.

For example, if all possible samples that could result under the ACS sample design were independently selected and surveyed under the same conditions, and if the estimate and its estimated standard error were calculated for each of these samples, then:

1. Approximately 68 percent of the intervals from one estimated standard error below the estimate to one estimated standard error above the estimate would contain the average result from all possible samples;

2. Approximately 90 percent of the intervals from 1.645 times the estimated standard error below the estimate to 1.645 times the estimated standard error above the estimate would contain the average result from all possible samples.

3. Approximately 95 percent of the intervals from two estimated standard errors below the estimate to two estimated standard errors above the estimate would contain the average result from all possible samples.

The intervals are referred to as 68 percent, 90 percent, and 95 percent confidence intervals, respectively.

Margin of Error – Instead of providing the upper and lower confidence bounds in published ACS tables, the margin of error is provided instead. The margin of error is the difference between an estimate and its upper or lower confidence bound. Both the confidence bounds and the standard error can easily be computed from the margin of error. All ACS published margins of error are based on a 90 percent confidence level.

Standard Error = Margin of Error / 1.645

Lower Confidence Bound = Estimate - Margin of Error

Upper Confidence Bound = Estimate + Margin of Error

When constructing confidence bounds from the margin of error, the user should be aware of any "natural" limits on the bounds. For example, if a characteristic estimate for the population is near zero, the calculated value of the lower confidence bound may be negative. However, a negative number of people does not make sense, so the lower confidence bound should be reported as zero instead. However, for other estimates such as income, negative values do make sense. The context and meaning of the estimate must be kept in mind when creating these bounds. Another of these natural limits would be 100 percent for the upper bound of a percent estimate.

If the margin of error is displayed as '*****' (five asterisks), the estimate has been controlled to be equal to a fixed value and so it has no sampling error. When using any of the formulas in the following section, use a standard error of zero for these controlled estimates.

Limitations –The user should be careful when computing and interpreting confidence intervals.

- The estimated standard errors (and thus margins of error) included in these data products do not include portions of the variability due to nonsampling error that may be present in the data. In particular, the standard errors do not reflect the effect of correlated errors introduced by interviewers, coders, or other field or processing personnel. Nor do they reflect the error from imputed values due to missing responses. Thus, the standard errors calculated represent a lower bound of the total error. As a result, confidence intervals formed using these estimated standard errors may not meet the stated levels of confidence (i.e., 68, 90, or 95 percent). Thus, some care must be exercised in the interpretation of the data in this data product based on the estimated standard errors.

- Zero or small estimates; very large estimates — The value of almost all ACS characteristics is greater than or equal to zero by definition. For zero or small estimates, use of the method given previously for calculating confidence intervals relies on large sample theory, and may result in negative values which for most characteristics are not admissible. In this case the lower limit of the confidence interval is set to zero by default. A similar caution holds for estimates of totals close to a control total or estimated proportion near one, where the upper limit of the confidence interval is set to its largest admissible value. In these situations the level of confidence of the adjusted range of values is less than the prescribed confidence level.

CALCULATION OF STANDARD ERRORS

This section discusses how the standard errors for published estimates are calculated and how users can calculate standard errors for estimates they derive for themselves. Examples demonstrating how to calculate standard errors for derived estimates starts on page 16.

The standard errors for published estimates, in most cases, are calculated using a replicate-based methodology that takes into account the sample design and estimation procedures.

It is calculated using the ACS estimate and the 80 replicate estimates computed using the replicate weights. The formula for the variance is provided below:

$$\text{Variance} = \frac{4}{80}\sum_{r=1}^{80}(X_r - X_0)^2$$

Where X_0 is the estimate calculated using the weights and X_r is the estimate calculated using the r^{th} replicate weight. The standard error is the square root of the variance. The 90^{th} percent margin of error is 1.645 times the margin of error.

For more information on the formation of the replicate weights, see chapter 12 of the Design and Methodology documentation at:
https://www.census.gov/programs-surveys/acs/methodology/design-and-methodology.html

Beginning with the ACS 2011 1-year estimates, the replicate weights also incorporated methodology to account for GQ imputation. The GQ imputation was developed to improve small-area estimates for the group quarter population. The total variance contains a non-negligible amount of imputation variance in addition to the sampling variance. This imputation variance was incorporated into the production of the replicate weights in order to minimize the impact on production tabulation systems. After the creation of the replicate weights, the sampling variance is calculated using the successive difference replication given in the above formula.

Excluding the base weights, replicate weights were allowed to be negative in order to avoid underestimating the standard error. Exceptions include:

1. The estimate of the number or proportion of people, households, families, or housing units in a geographic area with a specific characteristic is zero. A special procedure is used to estimate the standard error.

2. There are either no sample observations available to compute an estimate or standard error of a median, an aggregate, a proportion, or some other ratio, or there are too few sample observations to compute a stable estimate of the standard error. The estimate is represented in the tables by "-" and the margin of error by "**" (two asterisks).

3. The estimate of a median falls in the lower open-ended interval or upper open-ended interval of a distribution. If the median occurs in the lowest interval, then a "-" follows the estimate, and if the median occurs in the upper interval, then a "+" follows the estimate. In both cases the margin of error is represented in the tables by "***" (three asterisks).

Sums and Differences of Direct Standard Errors

The standard errors estimated from these tables are for individual estimates. Additional calculations are required to estimate the standard errors for sums of or the differences between two or more sample estimates.

The standard error of the sum of two sample estimates is the square root of the sum of the two individual standard errors squared plus a covariance term. That is, for standard errors $SE(\hat{X}_1)$ and $SE(\hat{X}_2)$ of estimates $\hat{X}_1$ and $\hat{X}_2$:

$$SE(\hat{X}_1 \pm \hat{X}_2) = \sqrt{[SE(\hat{X}_1)]^2 + [SE(\hat{X}_2)]^2 \pm 2cov(\hat{X}_1, \hat{X}_2)} \quad (1)$$

The covariance measures the interactions between two estimates. Currently the covariance terms are not available. Data users should use the approximation:

$$SE(\hat{X}_1 \pm \hat{X}_2) \approx \sqrt{[SE(\hat{X}_1)]^2 + [SE(\hat{X}_2)]^2} \quad (2)$$

However, this method will underestimate or overestimate the standard error if the two estimates interact in either a positive or negative way.

The approximation formula (2) can be expanded to more than two estimates by adding in the individual standard errors squared inside the radical. As the number of estimates involved in the sum or difference increases, the results of formula (2) become increasingly different from the standard error derived directly from the ACS microdata. Care should be taken to work with the fewest number of estimates as possible. If there are estimates involved in the sum that are controlled in the weighting then the approximate standard error can be increasingly different.

Ratios

The statistic of interest may be the ratio of two estimates. First is the case where the numerator *is not* a subset of the denominator.

The standard error of this ratio between two sample estimates is approximated as:

$$SE\left(\frac{\hat{X}}{\hat{Y}}\right) = \frac{1}{\hat{Y}}\sqrt{[SE\ (\hat{X})]^2 + \frac{\hat{X}^2}{\hat{Y}^2}[SE\ (\hat{Y})]^2} \quad (3)$$

Proportions/Percents

For a proportion (or percent), a ratio where the numerator *is* a subset of the denominator, a slightly different estimator is used. If $\hat{P} = \hat{X}/\hat{Y}$, then the standard error of this proportion is approximated as:

$$SE(\hat{P}) = \frac{1}{\hat{Y}}\sqrt{[SE\ (\hat{X})]^2 - \frac{\hat{X}^2}{\hat{Y}^2}[SE\ (\hat{Y})]^2} \quad (4)$$

If $\hat{Q} = 100\% \times \hat{P}$ (P is the proportion and Q is its corresponding percent), then $SE(\hat{Q}) = 100\% \times SE(\hat{P})$. Note the difference between the formulas to approximate the standard error for proportions (4) and ratios (3) - the plus sign in the previous formula has been replaced with a minus sign. If the value under the radical is negative, use the ratio standard error formula above, instead.

Percent Change

Calculating the percent change from one time period to another. Normally, the current estimate is compared to the older estimate.

Let the current estimate = $\hat{X}$ and the earlier estimate = $\hat{Y}$, then the formula for percent change is:

$$SE\left(\frac{\hat{X}-\hat{Y}}{\hat{Y}} \times 100\%\right) = 100\% \times SE\left(\frac{\hat{X}}{\hat{Y}} - 1\right) = 100\% \times SE\left(\frac{\hat{X}}{\hat{Y}}\right) \quad (5)$$

This reduces to a ratio. The ratio formula above may be used to calculate the standard error. As a caveat, this formula does not take into account the correlation when calculating overlapping time periods.

Products

For a product of two estimates - for example if you want to estimate a proportion's numerator by multiplying the proportion by its denominator - the standard error can be approximated as:

$$SE(\hat{X} \times \hat{Y}) = \sqrt{\hat{X}^2 \times [SE(\hat{Y})]^2 + \hat{Y}^2 \times [SE(\hat{X})]^2} \quad (6)$$

TESTING FOR SIGNIFICANT DIFFERENCES

Significant differences – Users may conduct a statistical test to see if the difference between an ACS estimate and any other chosen estimates is statistically significant at a given confidence level. "Statistically significant" means that the difference is not likely due to random chance alone. With the two estimates (Est_1 and Est_2) and their respective standard errors (SE_1 and SE_2), calculate a Z statistic:

$$Z = \frac{Est_1 - Est_2}{\sqrt{(SE_1)^2 + (SE_2)^2}} \quad (7)$$

If $Z > 1.645$ or $Z < -1.645$, then the difference can be said to be statistically significant at the 90 percent confidence level.[6] Any estimate can be compared to an ACS estimate using this method, including other ACS estimates from the current year, the ACS estimate for the same characteristic and geographic area but from a previous year, 2010 Census counts, estimates from other Census Bureau surveys, and estimates from other sources. Not all estimates have sampling error (2010 Census counts do not, for example), but they should be used if they exist to give the most accurate result of the test.

Users are also cautioned to *not* rely on looking at whether confidence intervals for two estimates overlap or not to determine statistical significance, because there are circumstances where that method will not give the correct test result. If two confidence intervals do not overlap, then the estimates will be significantly different (i.e. the significance test will always agree). However, if two confidence intervals do overlap, then the estimates may or may not be significantly different. The Z calculation above is recommended in all cases.

> Here is a simple example of why it is not recommended to use the overlapping confidence bounds rule of thumb as a substitute for a statistical test.
>
> Let: $Est_1 = 6.0$ with $SE_1 = 0.5$ and $Est_2 = 5.0$ with $SE_2 = 0.2$.
>
> The Lower Bound for $Est_1 = 6.0 - 0.5 * 1.645 = 5.2$ while the Upper Bound for $Est_2 = 5.0 + 0.2 * 1.645 = 5.3$. The confidence bounds overlap, so, the rule of thumb would indicate that the estimates are not significantly different at the 90% level.
>
> However, if we apply the statistical significance test we obtain:
>
> $$Z = \frac{6 - 5}{\sqrt{(0.5)^2 + (0.2)^2}} = 1.857$$
>
> $Z = 1.857 > 1.645$ which means that the difference is significant (at the 90% level).

All statistical testing in ACS data products is based on the 90 percent confidence level. Users should understand that all testing was done using *unrounded* estimates and standard errors, and it may not be possible to replicate test results using the rounded estimates and margins of error as published.

EXAMPLES OF STANDARD ERROR CALCULATIONS

We will present some examples based on the real data to demonstrate the use of the formulas. The examples are from the iteration for the Hmong Alone population at the national level.

---

[6] The ACS Accuracy of the Data document in 2005 used a Z statistic of +/-1.65. Data users should use +/-1.65 for estimates published in 2005 or earlier.

Hmong is a detailed Asian race group. The Hmong come from areas of China, Vietnam, Laos and Thailand. Note that except for example 5 the data is from the 2011-2015 ACS 5-year data.

Example 1 - Calculating the Standard Error from the Margin of Error

The estimated number of males, never married is 50,278 from summary table B12001 at the national level from Selected Population Tables for the Hmong Alone population. The margin of error is 1,577.

Standard Error = Margin of Error / 1.645

Calculating the standard error using the margin of error, we have:

$$\text{SE}(50{,}278) = \frac{1{,}577}{1.645} = 959$$

Example 2 - Calculating the Standard Error of a Sum or a Difference

We are interested in the number of people who have never been married for the Hmong Alone population. From Example 1, we know the number of males, never married is 50,278. From summary table B12001 we have the number of females, never married is 41,189 with a margin of error of 1,740. Therefore, the estimated number of people who have never been married is 50,278 + 41,189 = 91,467. To calculate the approximate standard error of this sum, we need the standard errors of the two estimates in the sum. We have the standard error for the number of males never married from example 1 as 959. The standard error for the number of females never married is calculated using the margin of error:

$$\text{SE}(41{,}189) \;=\; 1{,}740\;/\;1.645 \;=\; 1{,}058$$

So using formula (2) for the approximate standard error of a sum or difference we have:

$$\text{SE}(91{,}467) = \sqrt{959^2 + 1{,}058^2} = 1{,}428$$

Caution: This method will underestimate or overestimate the standard error if the two estimates interact in either a positive or negative way.

To calculate the lower and upper bounds of the 90 percent confidence interval around 91,467 using the standard error, simply multiply 1,428 by 1.645, then add and subtract the product from 91,467. Thus the 90 percent confidence interval for this estimate is [91,467 - 1.645(1,428)] to [91,467 + 1.645(1,428)] or 89,119 to 93,815.

Example 3 - Calculating the Standard Error of a Proportion/Percent

We are interested in the percentage of females who have never been married to the number of people who have never been married for the Hmong Alone population. The number of females, never married is 41,189 and the number of people who have never been married is 91,467. To calculate the approximate standard error of this percent, we need the standard errors of the two estimates in the percent. We have the approximate standard error for the number of females never married from example 2 as 1,058 and the approximate standard error for the number of people never married calculated from example 2 as 1,428.

The estimate is $(41{,}189 \,/\, 91{,}467) * 100\% = 45.03\%$

Therefore, using formula (4) for the approximate standard error of a proportion or percent, we have:

$$\mathrm{SE}(45.03\%) = 100\% * \left(\frac{1}{91{,}467}\sqrt{1{,}058^2 - 0.4503^2 * 1{,}428^2}\right) = 0.92\%$$

To calculate the lower and upper bounds of the 90 percent confidence interval around 45.03 using the standard error, simply multiply 0.92 by 1.645, then add and subtract the product from 45.03. Thus the 90 percent confidence interval for this estimate is [45.03 - 1.645(0.92)] to [45.03 + 1.645(0.92)], or 43.52% to 46.54%.

Example 4 - Calculating the Standard Error of a Ratio

Now, let us calculate the estimate of the ratio of the number of unmarried males to the number of unmarried females and its approximate standard error for the Hmong Alone population. From the above examples, the estimate for the number of unmarried men is 50,278 with a standard error of 959, and the estimate for the number of unmarried women is 41,189 with a standard error of 1,058.

The estimate of the ratio is 50,278 / 41,189 = 1.221.

Using formula (3) for the approximate standard error of this ratio we have:

$$\mathrm{SE}(1.221) = \frac{1}{41{,}189}\sqrt{959^2 + 1.221^2 * 1{,}058^2} = 0.039$$

The 90 percent margin of error for this estimate would be 0.039 multiplied by 1.645, or about 0.064. The 90 percent lower and upper 90 percent confidence bounds would then be [1.221 – 1.645(0.039)] to [1.221 + 1.645(0.039)], or 1.156 and 1.285.

Example 5 - Calculating the Standard Error of a Product

We are interested in the number of people in family households. The data for this example comes from the 2006-2010 ACS data. It is used for illustrative purposes. The number of family households for the Hmong Alone population was 38,972 with a margin of error of 1,236 from data profile DP02 for SPT, and the average family size was 5.47 with a margin of error of 0.11. So the number of people in family households was 38,972 * 5.47 = 213,177. Calculating the standard errors for the estimates using the margins of error we have:

$$\mathrm{SE}(38{,}972) = 1{,}236/1.645 = 751$$

and

$$\mathrm{SE}(5.47) = 0.11/1.645 = 0.07$$

The approximate standard error for the number of people in family households is calculated using formula (5) for products as:

$$\mathrm{SE}(213{,}177) = \sqrt{38{,}972^2 * 0.07^2 + 5.47^2 * 751^2} = 4{,}931$$

To calculate the lower and upper bounds of the 90 percent confidence interval around 213,177 using the standard error, simply multiply 4,931 by 1.645, then add and subtract the product from 213,177. Thus the 90 percent confidence interval for this estimate is [213,177 - 1.645(4,931)] to [213,177 + 1.645(4,931)] or 205,066 to 221,288.

CONTROL OF NONSAMPLING ERROR

As mentioned earlier, sample data are subject to nonsampling error. This component of error could introduce serious bias into the data, and the total error could increase dramatically over that which would result purely from sampling. While it is impossible to completely eliminate nonsampling error from a survey operation, the Census Bureau attempts to control the sources of such error during the collection and processing operations. Described below are the primary sources of nonsampling error and the programs instituted for control of this error. The success of these programs, however, is contingent upon how well the instructions were carried out during the survey.

- Coverage Error — It is possible for some sample housing units or persons to be missed entirely by the survey (undercoverage), but it is also possible for some sample housing units and persons to be counted more than once (overcoverage). Both the undercoverage and overcoverage of persons and housing units can introduce biases into the data, increase respondent burden and survey costs.

  A major way to avoid coverage error in a survey is to ensure that its sampling frame, for ACS an address list in each state, is as complete and accurate as possible. The source of addresses for the ACS is the MAF. An attempt is made to assign all appropriate geographic codes to each MAF address via an automated procedure using the Census Bureau TIGER (Topologically Integrated Geographic Encoding and Referencing) files. A manual coding operation based in the appropriate regional offices is attempted for addresses which could not be automatically coded. The MAF was used as the source of addresses for selecting sample housing units and mailing questionnaires. TIGER produced the location maps for CAPI assignments. Sometimes the MAF has an address that is the duplicate of another address already on the MAF. This could occur when there is a slight difference in the address such as 123 Main Street versus 123 Maine Street.

In the CATI and CAPI nonresponse follow-up phases, efforts were made to minimize the chances that housing units that were not part of the sample were interviewed in place of units in sample by mistake. If a CATI interviewer called a mail nonresponse case and was not able to reach the exact address, no interview was conducted and the case was eligible for CAPI. During CAPI follow-up, the interviewer had to locate the exact address for each sample housing unit. If the interviewer could not locate the exact sample unit in a multi-unit structure, or found a different number of units than expected, the interviewers were instructed to list the units in the building and follow a specific procedure to select a replacement sample unit. Person overcoverage can occur when an individual is included as a member of a housing unit but does not meet ACS residency rules.

Coverage rates give a measure of undercoverage or overcoverage of persons or housing units in a given geographic area. Rates below 100 percent indicate undercoverage, while rates above 100 percent indicate overcoverage. Further information about ACS coverage rates may be found at:
https://www.census.gov/acs/www/methodology/sample-size-and-data-quality/

- Nonresponse Error — Survey nonresponse is a well-known source of nonsampling error. There are two types of nonresponse error – unit nonresponse and item nonresponse. Nonresponse errors affect survey estimates to varying levels depending on amount of nonresponse and the extent to which nonrespondents differ from respondents on the characteristics measured by the survey. The exact amount of nonresponse error or bias on an estimate is almost never known. Therefore, survey researchers generally rely on proxy measures, such as the nonresponse rate, to indicate the potential for nonresponse error.

    - Unit Nonresponse — Unit nonresponse is the failure to obtain data from housing units in the sample. Unit nonresponse may occur because households are unwilling or unable to participate, or because an interviewer is unable to make contact with a housing unit. Unit nonresponse is problematic when there are systematic or variable differences between interviewed and noninterviewed housing units on the characteristics measured by the survey. Nonresponse bias is introduced into an estimate when differences are systematic, while nonresponse error for an estimate evolves from variable differences between interviewed and noninterviewed households.

The ACS makes every effort to minimize unit nonresponse, and thus, the potential for nonresponse error. First, the ACS used a combination of mail, CATI, and CAPI data collection modes to maximize response. The mail phase included a series of three to four mailings to encourage housing units to return the questionnaire. Subsequently, mail nonrespondents (for which phone numbers are available) were contacted by CATI for an interview. Finally, a subsample of the mail and telephone nonrespondents was contacted by personal visit to attempt an interview. Combined, these three efforts resulted in a very high overall response rate for the ACS.

ACS response rates measure the percent of units with a completed interview. The higher the response rate, and consequently the lower the nonresponse rate, the less chance estimates may be affected by nonresponse bias. Further information about response and nonresponse rates may be found at:
https://www.census.gov/acs/www/methodology/sample-size-and-data-quality/

- Item Nonresponse — Nonresponse to particular questions on the survey questionnaire and instrument allows for the introduction of error or bias into the data, since the characteristics of the nonrespondents have not been observed and may differ from those reported by respondents. As a result, any imputation procedure using respondent data may not completely reflect this difference either at the elemental level (individual person or housing unit) or on average.

  Some protection against the introduction of large errors or biases is afforded by minimizing nonresponse. In the ACS, item nonresponse for the CATI and CAPI operations was minimized by the requirement that the automated instrument receive a response to each question before the next one could be asked. Questionnaires returned by mail were edited for completeness and acceptability. They were reviewed by computer for content omissions and population coverage. If necessary, a telephone follow-up was made to obtain missing information. Potential coverage errors were included in this follow-up.

  Allocation tables provide the weighted estimate of persons or housing units for which a value was imputed, as well as the total estimate of persons or housing units that were eligible to answer the question. The smaller the number of imputed responses, the lower the chance that the item nonresponse is contributing a bias to the estimates. Allocation tables are released concurrent with the release of estimates on American Factfinder in the B99 series of detailed tables. Additional information on item nonresponse and allocations can be found at:
  https://www.census.gov/acs/www/methodology/sample-size-and-data-quality/

- Measurement and Processing Error — The person completing the questionnaire or responding to the questions posed by an interviewer could serve as a source of error, although the questions were cognitively tested for phrasing and detailed instructions for completing the questionnaire were provided to each household.

    - Interviewer monitoring — The interviewer may misinterpret or otherwise incorrectly enter information given by a respondent; may fail to collect some of the information for a person or household; or may collect data for households that were not designated as part of the sample. To control these problems, the work of interviewers was monitored carefully. Field staff were prepared for their tasks by using specially developed training packages that included hands-on experience in using survey materials. A sample of the households interviewed by CAPI interviewers was reinterviewed to control for the possibility that interviewers may have fabricated data.

    - Processing Error — The many phases involved in processing the survey data represent potential sources for the introduction of nonsampling error. The processing of the survey questionnaires includes the keying of data from completed questionnaires, automated clerical review, follow-up by telephone, manual coding of write-in responses, and automated data processing. The various field, coding and computer operations undergo a number of quality control checks to insure their accurate application.

    - Content Editing — After data collection was completed, any remaining incomplete or inconsistent information was imputed during the final content edit of the collected data. Imputations, or computer assignments of acceptable codes in place of unacceptable entries or blanks, were needed most often when an entry for a given item was missing or when the information reported for a person or housing unit on that item was inconsistent with other information for that same person or housing unit. As in other surveys and previous censuses, the general procedure for changing unacceptable entries was to allocate an entry for a person or housing unit that was consistent with entries for persons or housing units with similar characteristics. Imputing acceptable values in place of blanks or unacceptable entries enhances the usefulness of the data.