Comparing American Community Survey (ACS) Estimates Using Margins of Error

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Testing for a Statistical Difference

- Statistical testing is done to determine if a difference is unlikely to occur by chance.
- To be "statistically different" means there is statistical evidence that there is a difference.
- When you wish to make some statements that either directly or indirectly implies a comparison of two estimates, you need to check to make sure there is statistical evidence of a difference.

First, we will describe the process and then go through a worked example to demonstrate what to do. To begin, we show the z-score formula that we will be using for statistical testing:

$$\frac{|Est_1 - Est_2|}{\sqrt{MOE_{est1}{}^2 + MOE_{est2}{}^2}}$$

Here Est_1 and Est_2 represent the two estimates being compared, and MOE_{Est1} and MOE_{Est2} are the margins of error for the two estimates, respectively. If the result of this formula is greater than one (i.e., > 1.0), the estimates are statistically different. Table 3 shows the steps in the process.

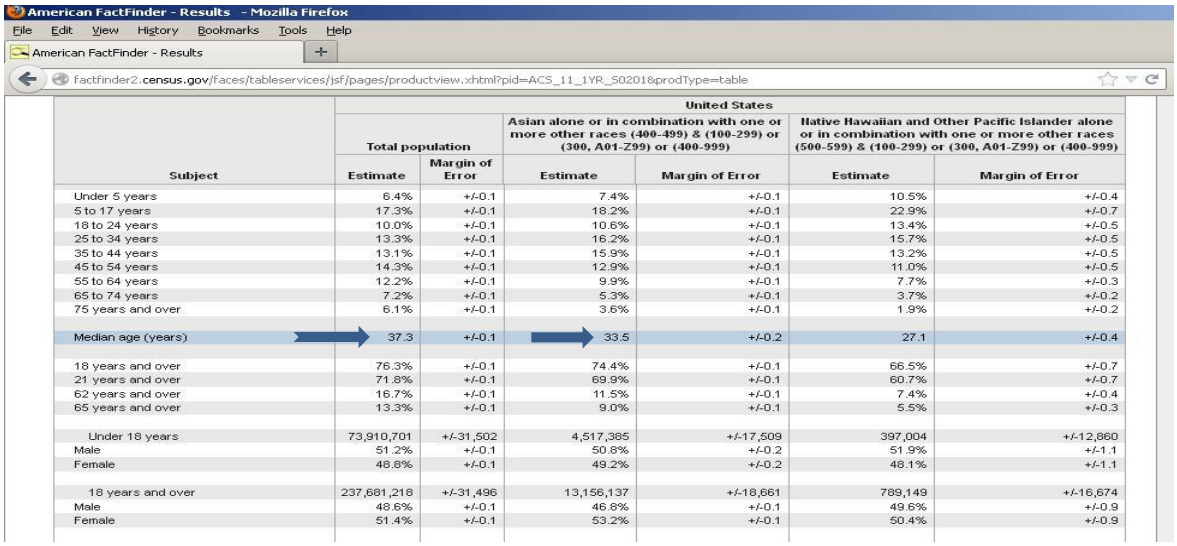
Table 3. Steps to Determine If Two Estimates are Statistically Different

Step	Process	Results
1	Find the difference of the estimates	$Est_1 - Est_2 = Diff$
2	Take the absolute value of difference (This makes sure the difference is always positive)	|Diff| = abs(Diff)
3	Square the MOEs of each estimate and add them together	$MOE_{Est1}{}^2 + MOE_{Est2}{}^2$
4	Take the square root of the sum	$\sqrt{MOE_{Est1}{}^2 + MOE_{Est2}{}^2}$
5	Divide difference by square root of sum	$\frac{Diff}{\sqrt{MOE_{Est1}{}^2 + MOE_{Est2}{}^2}}$
6	Compare result to 1.0	If greater than 1.0 then statistically different
		If less than 1.0 then not statistically different

This method can be used to compare two estimates of any type (count, percent, median, rate, etc.). You can compare estimates across geographic areas, between years, between non-overlapping multi-year periods, between estimates of two different surveys, and finally between survey estimates and census counts if the estimates and counts are comparable.

An Example of Statistical Testing:

The following is a demonstration of how to do a statistical test to show two estimates are statistically different. Suppose we want to answer the following question, "Is the median age of the Total population statistically higher than the median age of the Asian population?" First, we look up the median age of these two population and their MOEs in a table on AFF.



United States

Subject	Total population Estimate	Total population Margin of Error	Asian alone or in combination with one or more other races (400-499) & (100-299) or (300, A01-Z99) or (400-999) Estimate	Asian alone or in combination with one or more other races (400-499) & (100-299) or (300, A01-Z99) or (400-999) Margin of Error	Native Hawaiian and Other Pacific Islander alone or in combination with one or more other races (500-599) & (100-299) or (300, A01-Z99) or (400-999) Estimate	Native Hawaiian and Other Pacific Islander alone or in combination with one or more other races (500-599) & (100-299) or (300, A01-Z99) or (400-999) Margin of Error
Under 5 years	6.4%	+/-0.1	7.4%	+/-0.1	10.5%	+/-0.4
5 to 17 years	17.3%	+/-0.1	18.2%	+/-0.1	22.9%	+/-0.7
18 to 24 years	10.0%	+/-0.1	10.6%	+/-0.1	13.4%	+/-0.5
25 to 34 years	13.3%	+/-0.1	16.2%	+/-0.1	15.7%	+/-0.5
35 to 44 years	13.1%	+/-0.1	15.9%	+/-0.1	13.2%	+/-0.5
45 to 54 years	14.3%	+/-0.1	12.9%	+/-0.1	11.0%	+/-0.5
55 to 64 years	12.2%	+/-0.1	9.9%	+/-0.1	7.7%	+/-0.3
65 to 74 years	7.2%	+/-0.1	5.3%	+/-0.1	3.7%	+/-0.2
75 years and over	6.1%	+/-0.1	3.6%	+/-0.1	1.9%	+/-0.2
Median age (years)	37.3	+/-0.1	33.5	+/-0.2	27.1	+/-0.4
18 years and over	76.3%	+/-0.1	74.4%	+/-0.1	66.5%	+/-0.7
21 years and over	71.8%	+/-0.1	69.9%	+/-0.1	60.7%	+/-0.7
62 years and over	16.7%	+/-0.1	11.5%	+/-0.1	7.4%	+/-0.4
65 years and over	13.3%	+/-0.1	9.0%	+/-0.1	5.5%	+/-0.3
Under 18 years	73,910,701	+/-31,502	4,517,385	+/-17,509	397,004	+/-12,860
Male	51.2%	+/-0.1	50.8%	+/-0.2	51.9%	+/-1.1
Female	48.8%	+/-0.1	49.2%	+/-0.2	48.1%	+/-1.1
18 years and over	237,681,218	+/-31,496	13,156,137	+/-18,661	789,149	+/-16,674
Male	48.6%	+/-0.1	46.8%	+/-0.1	49.6%	+/-0.9
Female	51.4%	+/-0.1	53.2%	+/-0.1	50.4%	+/-0.9

We find the median age for the Asian population alone or in combination is 33.5 with a MOE of +/- 0.2 and the median age for the Total population is 37.3 with a MOE of +/- 0.1.

We now have everything we need to start the statistical testing. Table 4 shows the process and result using the steps we saw earlier in Table 3.

Table 4. Determining If Two Median Ages are Statistically Different

Step	Process	Result
1	Find the difference of the estimates	33.5 – 37.3 = -3.8
2	Take the absolute value of difference	|-3.8| = abs(-3.8) = 3.8
3	Square the MOEs of each estimate	$0.2^2 = 0.04,\ 0.1^2 = 0.01$
4	Take the square root of the sum	$\sqrt{0.04 + 0.01} = \sqrt{0.05}$
5	Divide difference by square root of sum	$3.8 / \sqrt{0.05} = 16.99$
6	Compare result to 1.0	16.99 > 1.0

7	Median age for Total pop is statistically higher than Asian pop

To see it all put together in the z-score formula:

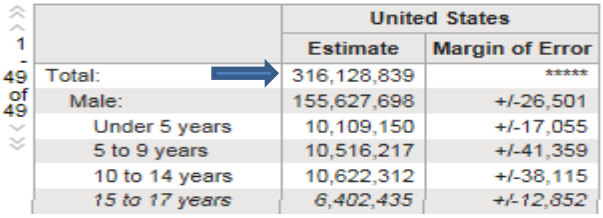
$$\frac{|33.5 - 37.3|}{\sqrt{(0.2)^2 + (0.1)^2}} = 16.99 > 1.0$$

Statistical Testing Special Cases

There are a few situations where statistical testing is more challenging or not possible.

a. Controlled Estimates

These estimates are controlled or fixed to be a value from the official Population Estimates Program. These estimates have no variation and have a MOE = ***** (five asterisks) assigned.



	United States	
	Estimate	Margin of Error
Total:	316,128,839	*****
Male:	155,627,698	+/-26,501
Under 5 years	10,109,150	+/-17,055
5 to 9 years	10,516,217	+/-41,359
10 to 14 years	10,622,312	+/-38,115
15 to 17 years	6,402,435	+/-12,852

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In order to do a statistical test that compares a regular estimate to a controlled estimate, the MOE = ***** should be replaced with a MOE = 0.

b. Zero Estimate MOEs

In the ACS estimates that are zero are assigned non-zero MOEs. The MOEs for zero estimates may vary by geography. In order to do a statistical test that compares a regular estimate to a zero estimate, the test should be done using the assigned MOE.

	Delaware		District of Columbia		Maryland		Virginia	
	Estimate	Margin of Error	Estimate	Margin of Error	Estimate	Margin of Error	Estimate	Margin of Error
Total:	567	+/-337	233	+/-94	2,570	+/-367	5,633	+/-541
Male:	261	+/-159	134	+/-90	1,271	+/-263	2,697	+/-336
Under 5 years	36	+/-56	0	+/-29	29	+/-23	132	+/-62
5 to 9 years	0	+/-27	0	+/-29	110	+/-93	82	+/-47
10 to 14 years	0	+/-27	34	+/-48	55	+/-50	324	+/-117
15 to 17 years	0	+/-27	0	+/-29	78	+/-82	141	+/-97
18 and 19 years	3	+/-8	0	+/-29	20	+/-25	144	+/-89
20 to 24 years	2	+/-4	0	+/-29	363	+/-314	340	+/-186
25 to 29 years	2	+/-6	0	+/-29	131	+/-99	419	+/-170

For example:

$$\frac{|36 - 0|}{\sqrt{(56)^2 + (27)^2}}$$

c. Medians and Aggregates Estimates

There are two cases, where median and aggregate estimates **cannot** be tested for statistical differences.

i. When medians and aggregates are based on too few observations, estimates are assigned the symbol "-" and their MOEs = "**" (two asterisks).

ii. When medians are located in the highest or lowest category, the estimates will have a "+" or "-" after it and the MOE will be given three asterisks. For example: the median income in the past 12 months is given as "$2,500-" and its MOE = "***".