



Supplemental Data User Guideline:
What are Confidence Intervals?
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For many of us, only a few of the topics we studied in Statistics class (or would have studied, had we taken such a class) find use in our professional roles in the field of public health advocacy. One of those few, however, is the confidence interval (CI). The problem is that, although the concept plays a major role in how we communicate data, what we know, and what we don't know, the reasoning behind them often feels obscure and somewhat backwards.

This is a brief discussion of what confidence intervals are and how to use them; it is intended for the public health advocates involved in CAFA who have the desire to think through the basic concepts. For the sake of clarity, we will proceed through the use of a concrete example of survey research. The discussion will not include the mathematical foundations of CIs, which tend to be available in textbooks, etc.

An example: Looking for Lefty

As an example, let's say we want to answer a (relatively) simple question: How much of the California population is left-handed? When you think about it, there is only one way to **know** the answer for certain, and that is to ask everyone in California if they are left-handed. The answer would be a number you could express as a percent, say 15%.

It's pretty easy to see, of course, why we would want to try a random sample of Californians, instead of asking all 33 million of us. But what can we really say based on our random sample? If we only ask two people, and one is left-handed, few of us would feel ready to

proclaim that 50% of the population is left-handed. Rather, we would know that the percent is not zero and not 100, but somewhere in between.

Similarly, we might ask 5 people and find out that one of them is left-handed. At this point, we might begin to suspect that the true number is less than 50%, although we wouldn't be terribly surprised if this too turned out to be false upon further investigation. Certainly, we would feel uncomfortable telling the media that the true figure was exactly 1/5, or 20%.

We have to accept that, unless we are willing to survey **every** Californian, the rate of left-handedness will always be an **estimate**, and there will be a **range** of values around the estimate within which we are reasonably certain that the true rate lies. This range is known as the **confidence interval**; as you might expect, the more people we survey, the narrower this range gets (or in other words, the more precise our estimate becomes). This is why, in the graph on the following page, the confidence intervals for LA are narrower than those for the other two counties—the sample size for LA was much larger.

Assumptions

There several assumptions that we have to make in order for confidence intervals to make sense; here I will just mention two.

The first is that there is a "real" rate out there (the real percent of left-handed people, or the real asthma prevalence, etc), but that we have no way to measure it directly. Therefore, when we talk about

the “95%-confidence interval,” we’re saying “we are 95% certain that this range covers the real rate” (this language is slightly sloppy but conveys the idea reasonably well, so we’ll use it here).

This is of course puts us in an awkward position, because unless we are speaking to an audience of statisticians, they are unlikely to be making the distinction between “reality” and our “estimate.” In their own minds, most people equate the estimated rate (which is somewhere inside the range of the confidence interval) with a measured “reality.”

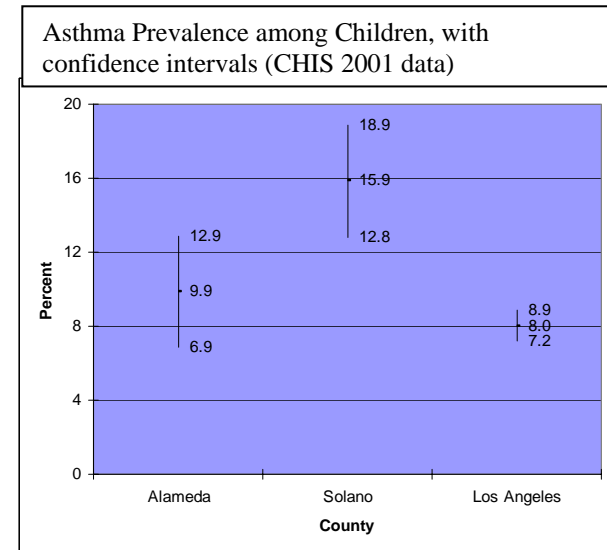
The other assumption is that, during your survey, you really are collecting a random sample. Therefore, you don’t only ask males, or people of a certain race. Otherwise your estimate may be inaccurate when applied to all Californians.

Can I use confidence intervals to test for significance?

A very common practice is to look at confidence intervals for two rate estimates, especially if they are presented in a graph, and to see if they overlap. For example, the confidence intervals for Alameda overlap with both those of Solano and those of LA, while those of Solano and LA do not overlap each other (see picture). If the confidence intervals overlap, then it is said that the two values are not “statistically significantly different” from each other.

Is this practice valid? As it turns out, this method tends to under-estimate statistical significance. This is to say that it is possible to have two overlapping confidence intervals when the estimates are actually statistically significantly different. The converse, however, is not true—if the confidence intervals do not

overlap, you can be sure that the two estimates are statistically significant from each other.



Therefore, confidence intervals may be used as a “rule of thumb” for statistical significance, but if the question of significance is important, more information is usually needed.

The Confidence Level

Confidence intervals are always reported with a **confidence level**, expressed as a percent. Most commonly this level is 95%, but sometimes it’s 90% or 99% (It’s never 100%—can you see why?).

There is no magic rule telling us which confidence level to use; it’s just as valid to say “we are 90% certain that the rate falls in range x” as it is to say “we are 99% certain that the rate falls in range y.” What is crucial to understand, is that y will always be a wider range than x. If you choose to use 90%-confidence intervals, they will necessarily look narrower than the 99%-confidence intervals, given the same data.

When should I pay attention to confidence intervals?

The answer to this question is, “nearly always!” Whenever the rate is an estimate (that is, a number derived from a population sample), the confidence interval is essential information. Especially if we want to rank, for example, which county has the higher asthma prevalence, then confidence interval is **more important** than the actual estimated rate. This is because we don’t want to over-state what we actually know about asthma in counties, based on the information gathered.

The opinions expressed here are those of the author. The material is being presented on behalf of CAFA.