

## Biostatistics: PRECISION AND ACCURACY

### 1. Introduction

We often tend to use the words 'precise' and 'accurate' to mean roughly the same thing. Look the words up in a thesaurus and they both equate to truth or exactness. However, in measurements and statistics, the two words have different meanings, so that you can be precise without being accurate or accurate without being precise.

### 2. Statistical precision and accuracy

One of the basic activities in statistics is assessing whether the answer derived from a small number of observations (a sample) is representative of the much larger number of entities (the population) from which the sample has been drawn. It is most unlikely that either the sample or the population will be uniform – each will have an average value (typically a mean) and measurements will vary around this mean. The average and variability define precision and accuracy.

#### 2.1 'Precise and accurate'

The average value from a sample is **precise** if the sample as a whole has low variability. It is an **accurate** representation of the parent population if this average is very close to the 'real' average for the population. If we use a dartboard as an analogy, darts (sample measurements) all land close to the bullseye of the dartboard (representing the population mean):



## 2.2 'Precise but inaccurate'

In our everyday use of the words, this expression seems paradoxical. However, using the definitions in the previous section, we can understand that a sample can be **precise** where there is little variability around the average value, but is **inaccurate** because the sample average is different from the population average. Again, using the dartboard analogy, darts land in a tight cluster but they are far from the bullseye:



## 2.3 'Imprecise but accurate'

The opposite situation may occur. If the sample measurements are very variable, the average will be **imprecise**. However, the sample average may be very close to the population average, in which case the sample average is an **accurate** measure of the population average. On our dartboard, the darts have landed over a wide area, but the average of their positions is close to the bullseye:



## 2.4 'Imprecise and inaccurate'

This final category will be self-evident. If the sample is highly variable, the average value will be imprecise, and if the average is very different from the population average, the sample average will be an inaccurate measure of the population as a whole. This looks like:

