Sample

A subset of a population.

- A random sample is a subset where every item in the population has the same probability of being in the sample.
- **Usually, the size of the sample is much less than the size of the population**.
- The primary goal of much research is to use information collected from a sample to try to characterize a certain population.
- As such, you should pay a lot of attention to **how representative the sample is of the population**.
- If there are problems, with representativeness, consider redefining your population a bit more narrowly. For example, a sample of 85 smokers between the ages of 13 and 18 in Rochester, Minnesota who respond to an advertisement about participation in a smoking cessation program might not be considered representative of the population of all teenage smokers, because the participants selected themselves. The sample might be more representative if we restrict our population to those teenage smokers who want to quit.

Population

A collection of items of interest in research.

- The population represents a group that you wish to generalize your research to.
- Populations are often **defined in terms of demography, geography, occupation, time, care requirements, diagnosis, or some combination of the above**.
- Contrast this with a definition of a sample. An example of a population would be:
- all infants born in the state of Missouri during the 1995 calendar year who have one or more visits to the Emergency room during their first year of life.

Statistic

A statistic is a number computed from a sample.

- If a statistic is computed from a random sample (as is typically the case), then it has random variation or sampling error. An example of a statistic would be:

    - the average length of stay in the birth hospital for a random sample of 387 infants born in Johnson County, Kansas.

Standard error

The standard error is the **estimated standard deviation of a statistic**.

- The formula depends on what statistic you are talking about. For example, **the standard error of a sample mean is just the sample standard deviation divided by the square root of the sample size**. For more complicated statistics, the standard error is also more complicated.

You can use the standard error in two ways. First, the **statistic divided by the standard error gives you a way of testing whether the parameter that your statistic is estimating equals zero**. You compare this ratio to a t-distribution. In most contexts, the ratio of the statistic divided by its standard error is called a Wald test. For many simple applications, you can also call this a t-test.

A second application of the standard error is the production of confidence intervals. **You can get a crude confidence interval by taking your statistic plus or minus two standard errors**. A more precise confidence interval would use percentiles from the t-distribution.

There are a lot of subtleties in the use of the standard error, especially in more complex problems. Sometimes, for example, the standard error applies not to the statistic itself, but to the logarithm of that statistic. For example, **a logistic regression model will compute an odds ratio for your data, but the standard error refers not to the odds ratio, but to the log odds ratio**. In this situation, you need to **compute the confidence interval on the log scale and then transform the results back to the original scale of measurement**.

Experimental design

A research design where the researchers control the allocation of a treatment to the research subjects. Contrast this with an observational design, where the researchers do not have this control. Information from an experimental design is generally considered more authoritative than information from an observational design. For example, randomization is possible when the authors control group membership. Randomization provides some level of assurance that the two groups are comparable in every way except for the therapy received. Here are two examples of experimental designs:

- In Adkinson (1997), 121 children with moderate-to-severe asthma were "randomly assigned to receive subcutaneous injections of either a mixture of seven aeroallergen extracts or a placebo." Since the researchers generated the sequence of random assignment, this is an experimental design.
- In Bullock (1989), "80 severe recidivist alcoholics received accupuncture either at points specific for the treatment of substance abuse (treatment group) or at nonspecific points (control group)." Since the researchers controlled the nature of the accupuncture, this is an experimental design.

Random sample

A random sample is one where the researcher insures (usually through the use of random numbers applied to a list of the entire population) that each member of that population has an equal probability of being selected. Random samples are an important foundation of Statistics. Almost all of the mathematical theory upon which Statistics are based rely on assumptions which are consistent with a random sample.

Purely random samples are hard to achieve in the real world, but many times you can come close. The biggest problem is that you may not have a complete list of the population that you want to randomly draw from. The telephone book for a city, for example, will list most households, but will exclude those who do not have a telephone, those who have unlisted numbers, and most recently, those who use a cell phone instead of a land phone for all their calls (cell phone numbers are usually not in the telephone book).

A second barrier to purely random samples is that for some people in the population, you will find it difficult or impossible to locate them. People who work unusual hours or who travel a lot may end up getting selected in the sample, but may never be around to answer the telephone.

Longitudinal design.

A research design where **subjects are assessed at several different times** in their lives. Usually, you use this design when you are interested in how subjects change over time. These studies are often expensive, difficult to conduct, and have lots of trouble without drop outs. They also will require more complex statistical analyses. But they provide a wealth of information that could not be obtained readily with other types of research designs. Here are two examples of longitudinal designs.

- In Phillips et al (BMJ 2001 Mar 31;322(7289):771), the researchers studied 3577 men born at the Helsinki University Central Hospital, Finland, during 1924-33. They collected data at birth on gestational age, birth weight, and head circumference. They also measured their weight at 15 years, and their marital status and socioeconomic status as adults. This longitudinal study came up with the surprising conclusion that men who were small at birth were less likely to be married as adults.
- In Kivipelto et al (BMJ 2001 Jun 16;322(7300):1447-51), the researchers re-contacted patients in 1998 who had originally be assessed as part of a different study in either 1972, 1977, 1982, or 1987. They assesses whether the patients had signs of Alzhiemers disease in 1998 and correlated this with their blood pressure and cholesterol measurements at the earlier time. This longitudinal study showed that high levels of systolic blood pressure and high levels of cholesterol at mid-life were associated with increased risk of Alzheimers disease later in life.

Cross sectional design

A research design where **subjects are assessed at a single time** in their lives. A cross sectional study is fast and can study a large number of patients at little cost or effort. Also, you don't have to worry about patients dropping out during the course of the study. This study is efficient at identifying association, but may have trouble deciding cause and effect. With data at only one time point, you don't know whether the chicken or the egg came first. Here are two examples of cross sectional designs.

- In Zureik et al (BMJ 2002 Aug 24;325(7361):411), a group of 1132 adults with asthma were given respiratory function tests to assess the severity of their asthma. They were also given skin prick tests to assess their sensitization to mold, pollen, dust mites, and cats. In this study, those patients with reactions to mold were much more likely to have severe asthma.
- In Garrett et al (BMJ 2002 Jun 22;324(7352):1494), a group of 190 mothers of normal healthy infants attending one of nine child care centers in Ireland, were surveyed. These mothers were asked to recall when their babies achieved certain developmental milestones, and whether they used baby walkers. In this study, babies who used baby walkers had significant delays in when they first crawled, stood up alone, and walked alone.

Descriptive study

A study that tries to reveal patterns associated with a specific disease without an emphasis on pre-specified hypotheses. Sometimes these types of studies are called hypothesis generating studies (to contrast them with hypothesis testing studies). There are three general reasons that you might want to conduct a descriptive study:

1. to help in planning resource allocation;
2. to identify areas for further research
3. to provide informal diagnostic information.

Generally, in a descriptive study, the emphasis is on estimation rather than testing. Some of the quantites you might want to estimate are:

1. the prevalance of a disease,
2. the natural history of a disease.
3. the resources required to treat the disease.
4. attitudes and perceptions about the disease.