What are inferential statistics?

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Inferential statistics is one of the two main branches of statistics.

Inferential statistics use a random sample of data taken from a population to describe and make inferences about the population. Inferential statistics are valuable when examination of each member of an entire population is not convenient or possible. For example, to measure the diameter of each nail that is manufactured in a mill is impractical. You can measure the diameters of a representative random sample of nails. You can use the information from the sample to make generalizations about the diameters of all of the nails.

Inferential Statistics

With inferential statistics, you are trying to reach conclusions that extend beyond the immediate data alone. For instance, we use inferential statistics to try to infer from the sample data what the population might think. Or, we use inferential statistics to make judgments of the probability that an observed difference between groups is a dependable one or one that might have happened by chance in this study. Thus, we use inferential statistics to make inferences from our data to more general conditions; we use descriptive statistics simply to describe what's going on in our data.

Here, I concentrate on inferential statistics that are useful in experimental and quasi-experimental research design or in program outcome evaluation. Perhaps one of the simplest inferential test is used when you want to compare the average performance of two groups on a single measure to see if there is a difference. You might want to know whether eighth-grade boys and girls differ in math test scores or whether a program group differs on the outcome measure from a control group. Whenever you wish to compare the average performance between two groups you should consider the t-test for differences between groups.

Most of the major inferential statistics come from a general family of statistical models known as the General Linear Model. This includes the t-test, Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA), regression analysis, and many of the multivariate methods like factor analysis, multidimensional scaling, cluster analysis, discriminant function analysis, and so on. Given the importance of the General Linear Model, it's a good idea for any serious social researcher to become familiar with its workings. The discussion of the General Linear Model here is very elementary and only considers the simplest straight-line model. However, it will get you familiar with the idea of the linear model and help prepare you for the more complex analyses described below.

One of the keys to understanding how groups are compared is embodied in the notion of the "dummy" variable. The name doesn't suggest that we are using variables that aren't very smart or, even worse, that the analyst who uses them is a "dummy"! Perhaps these variables would be better described as "proxy" variables. Essentially a dummy variable is one that uses discrete numbers, usually 0 and 1, to represent different groups in your study. Dummy variables are a simple idea that enable some pretty complicated things to happen. For instance, by including a simple dummy variable in an model, I can model two separate lines (one for each treatment group) with a single equation. To see how this works, check out the discussion on dummy variables.

One of the most important analyses in program outcome evaluations involves comparing the program and non-program group on the outcome variable or variables. How we do this depends on the research design we use. research designs are divided into two major types of designs: experimental and quasi-experimental. Because the analyses differ for each, they are presented separately.

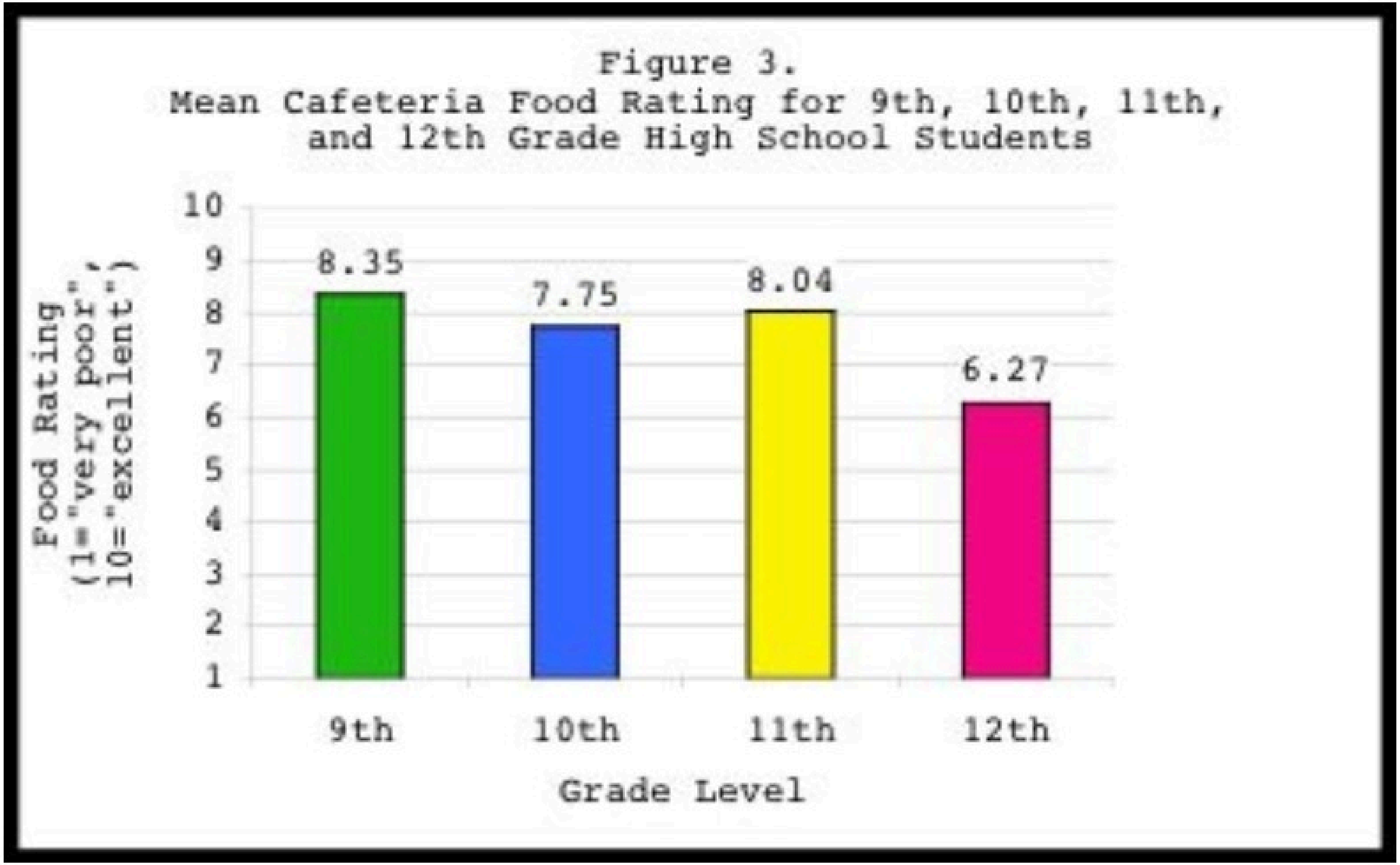
Descriptive statistics describes data (for example, a chart or graph) and **inferential statistics** allows you to make predictions ("inferences") from that data. With inferential statistics, you take data from samples and make generalizations about a population. For example, you might stand in a mall and ask a sample of 100 people if they like shopping at Sears. You could make a bar chart of yes or no answers (that would be descriptive statistics) or you could use your research (and inferential statistics) to reason that around 75-80% of the population (**all** shoppers in **all malls**) like shopping at Sears.

There are two main areas of inferential statistics:

1. Estimating parameters. This means taking a statistic from your sample data (for example the sample mean) and using it to say something about a population parameter (i.e. the population mean).
2. Hypothesis tests. This is where you can use sample data to answer research questions. For example, you might be interested in knowing if a new cancer drug is effective. Or if breakfast helps children perform better in schools.

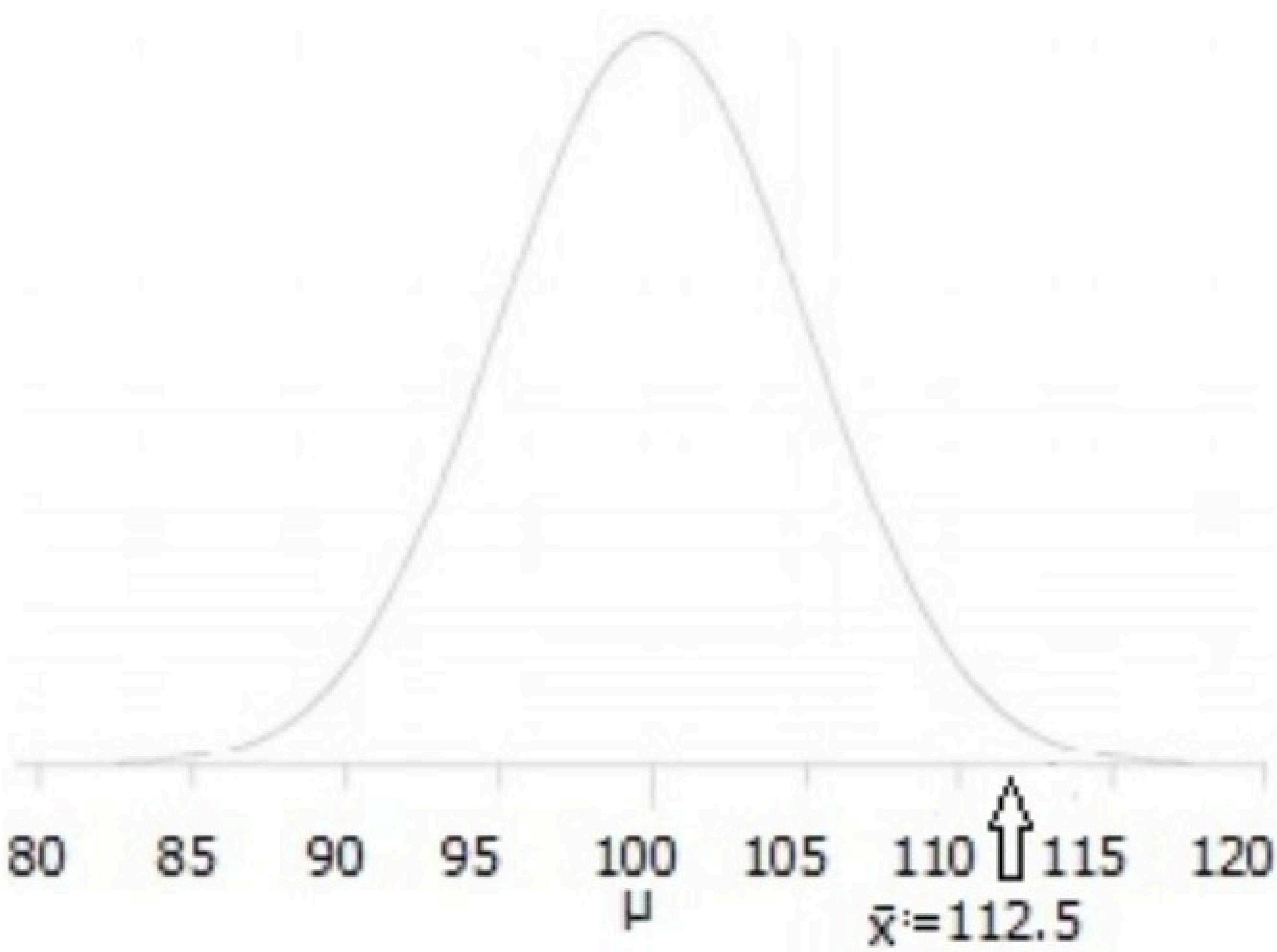
Let's say you have some sample data about a potential new cancer drug. You could use descriptive statistics to describe your sample, including:

- Sample mean
- Sample standard deviation
- Making a bar chart or boxplot
- Describing the shape of the sample probability distribution



A bar graph is one way to summarize data in descriptive statistics. Source: NIH.GOV.

With inferential statistics you take that sample data from a small number of people and and try to determine if the data can predict whether the drug will work for everyone (i.e. the population). There are various ways you can do this, from calculating a z-score (z-scores are a way to show where your data would lie in a normal distribution to post-hoc (advanced) testing.



A hypothesis test can show where your data is placed on a distribution like this one.

Inferential Statistics

Inferential statistics are often used to compare the differences between the treatment groups. Inferential statistics use measurements from the sample of subjects in the experiment to compare the treatment groups and make generalizations about the larger population of subjects.

There are many types of inferential statistics and each is appropriate for a specific research design and sample characteristics. Researchers should consult the numerous texts on experimental design and statistics to find the right statistical test for their experiment. However, most inferential statistics are based on the principle that a test-statistic value is calculated on the basis of a particular formula. That value along with the degrees of freedom, a measure related to the sample size, and the rejection criteria are used to determine whether differences exist between the treatment groups. The larger the sample size, the more likely a statistic is to indicate that differences exist between the treatment groups. Thus, the larger the sample of subjects, the more powerful the statistic is said to be.