

Review of Basic Statistical Concepts

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Learning Objectives

Define and describe the null and alternative hypotheses.

Describe probability density functions and p-values.

Define Type 1 error.

Define and describe power and the factors that influence it.

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The goal of most scientific research is to test hypotheses

Hypotheses are theories about how the world works.

Hypotheses often describe the relationship between two or more events and allow scientists to describe average response for two or more groups.

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A null hypothesis states that an event does not happen

Null hypotheses are the logical negation of hypotheses.

Null hypotheses claim that there is no association between two or more events, or no difference in average response for two or more groups.

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For the course, you must first understand power and hypotheses

Power is the probability of rejecting a null hypothesis.

The scientific goal is to reject the null hypothesis.

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In study design, power is used to calculate how many participants should be included in a study



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Scientific research depends on the calculation of probabilities

Cumulative distribution functions are equations used to calculate the probability of an outcome for given values of an independent variable.

Example: Given a patient's daily diet contains 4000mg of sodium, the probability of a heart attack by age 60 is 20%.

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Scientific research depends on the calculation of probabilities

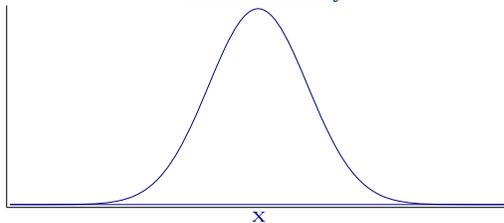
Many useful random variables that are continuous have density functions which are used to compute their cumulative distribution functions and in turn probabilities of interest.

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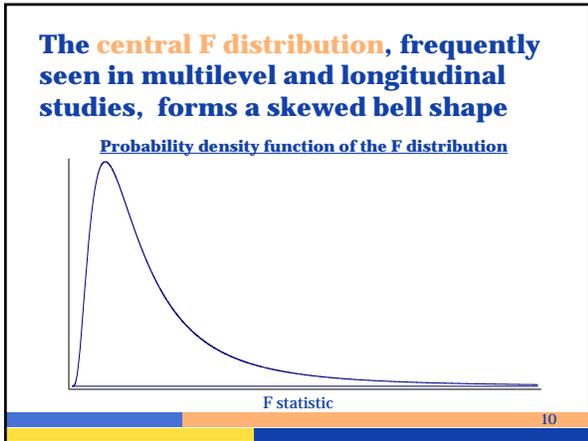
When graphed, probability density functions take on highly characteristic shapes

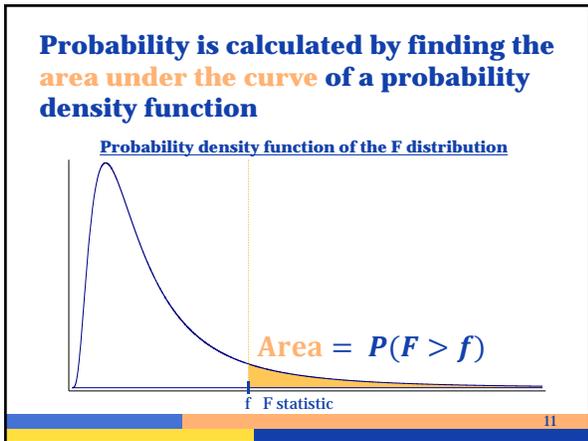
Example:

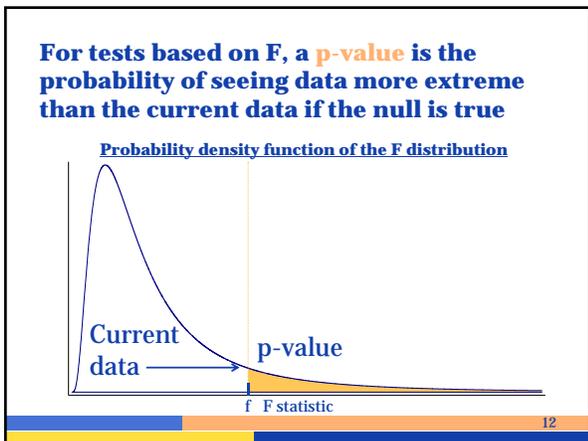
The normal density



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Small p-values lead researchers to achieve their goal of rejecting the null hypothesis

A **Type I error** occurs when a statistical test mistakenly rejects the null hypothesis when in fact the null hypothesis is true.

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Scientists only trust findings if several studies come to the same conclusion

Replicated findings are findings from subsequent studies that match the original findings.

Scientific knowledge grows from the steady accretion of replicated studies.

Science: public and replicable.

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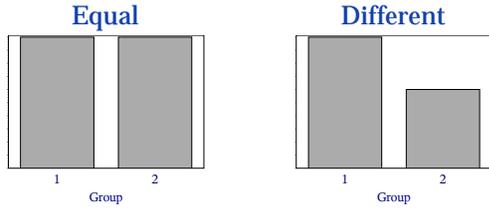
Outside of scientific studies, we often talk about two events being related

A **null hypothesis** claims that the two events are **NOT** related.

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In this course we focus on hypotheses about average responses for groups

Average responses for two or more groups are either:



Power is the probability of rejecting a null hypothesis

Achieving an appropriately high power, such as **0.9**, lends researchers confidence in the accuracy of a study's conclusions.

Power depends on a few things

1. Study design, including sample size (how many participants are in the study)
2. Strength of relationship between events
3. Degree of variability in the system
4. Statistical test
5. Type I error rate

Review Summary

- Hypotheses often describe the **relationship** between two or more events and allow scientists to describe average response for two or more groups.
- Null hypotheses claim that there is no **association** between two or more events.
- **Power** is the probability of rejecting a null hypothesis. Our scientific goal is to reject the null hypothesis.

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