

# What is the difference between Balanced and Unbalanced Designs?

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Balanced and unbalanced designs are two types of experimental designs used in research studies. A balanced design is one in which all groups or conditions have an equal number of participants, while an unbalanced design does not have an equal distribution of participants across all groups or conditions. In a balanced design, each group or condition has the same number of participants, which allows for a fair comparison between the groups. On the other hand, an unbalanced design may have a varying number of participants in each group, which can make it difficult to interpret the results accurately. Overall, the main difference between balanced and unbalanced designs lies in the allocation of participants to different groups or conditions, which can affect the validity and reliability of the study's findings.

## **Balanced vs. Unbalanced Designs: What's the Difference?**

**In statistics, ANOVA ("analysis of variance") models are used to determine whether or not the means of different treatment levels are equal.**

**An ANOVA has a balanced design if the sample sizes are equal across all treatment combinations.**

**Conversely, an ANOVA has an unbalanced design if the sample sizes are *not* equal across all treatment combinations.**

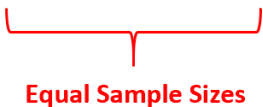
**For example, suppose we want to perform a to determine if three different fertilizers cause the same mean growth in plants.**


**The following graphic shows an example of a balanced**

## and unbalanced design for this one-way ANOVA:

### One-Way ANOVA

Balanced Design				Unbalanced Design			
Treatment	Fertilizer 1	Fertilizer 2	Fertilizer 3	Treatment	Fertilizer 1	Fertilizer 2	Fertilizer 3
Sample Size	20	20	20	Sample Size	20	18	17





In the balanced design, there are an equal number of plants in each treatment. In the unbalanced design, there are unequal sample sizes.

Or suppose we want to perform a to determine if different combinations of fertilizer and sunlight cause the same mean growth in plants.


The following graphic shows and example of a balanced and unbalanced design for this two-way ANOVA:

## Two-Way ANOVA

Balanced Design			
	Fertilizer 1	Fertilizer 2	Fertilizer 3
Low Sunlight	20	20	20
High Sunlight	20	20	20

  
Equal Sample Sizes

Unbalanced Design			
	Fertilizer 1	Fertilizer 2	Fertilizer 3
Low Sunlight	20	14	17
High Sunlight	19	18	20

  
Unequal Sample Sizes

### Why is a Balanced Design Preferred?

Balanced designs offer the following advantages over unbalanced designs:

1. The power of an ANOVA is highest when sample sizes are equal across all treatment combinations. When the power is highest, we have the best chance of detecting differences among the means across treatment combinations when the means truly are different.
2. The overall F-statistic of the ANOVA is less sensitive to violations of the .

### How do Unbalanced Designs Occur?

Even if researchers attempt to set up a balanced design

**for an ANOVA, there are several reasons why an unbalanced design could occur, including:**

**Individuals may decide to opt out of a study halfway through  
Plants may simply die during the course of the study  
A manufacturing plant may shut down and not be able to deliver certain components needed for a study.**

**There are tons of reasons why an experiment may suddenly become an unbalanced design.**

**How to Handle Unbalanced Designs**

**As mentioned earlier, balanced designs are preferred because they offer higher statistical power and more reliable test statistics.**

**However, if you do have to perform an experiment using an unbalanced design, you have three choices:**

**1. Proceed with an ANOVA anyway.**

**If the sample sizes across treatment combinations are not equal, but the assumption of equal variances is met, you can still proceed to perform an ANOVA anyway.**

**It's well-known that ANOVA's are fairly robust to**

**unequal sample sizes if the variances across each treatment combination are still equal.**

## **2. Impute missing values.**

**If there are only slight differences among sample sizes between treatment combinations, you could impute missing values using the mean or median of the treatment levels.**

**However, this approach should be used with caution and should only be used when sample sizes are nearly equal to begin with.**

## **3. Perform a non-parametric test.**

**If the sample sizes are not equal and the assumption of equal variances is violated, you could instead perform a non-parametric equivalent to an ANOVA such as the .**

**This type of test is much more robust to unequal sample sizes and unequal variances across treatment combinations.**