# What is Mauchly’s Test of Sphericity and how is it used in statistical analysis? Can you provide an example of its application?

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May 6, 2024



RECOMMENDED CITATION

stats writer (2024). *What is Mauchly’s Test of Sphericity and how is it used in statistical analysis? Can you provide an example of its application?*. PSYCHOLOGICAL SCALES. Retrieved from https://scales.arabpsychology.com/?p=143241

Mauchly's Test of Sphericity is a statistical test used to assess whether the variances of multiple groups in a dataset are equal. It is commonly used in analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA) to determine if the assumption of equal variances, also known as the assumption of sphericity, is met.

In statistical analysis, the assumption of equal variances is important because it affects the accuracy of the results and conclusions drawn from the data. If the assumption of sphericity is violated, it can lead to incorrect conclusions and unreliable statistical tests.

To perform Mauchly's Test of Sphericity, the variances of each group in the dataset are calculated and compared. The test then determines if there is a significant difference in the variances between the groups. If the p-value of the test is less than the chosen significance level, it indicates that the assumption of sphericity is violated and further analysis may be needed.

For example, in a study comparing the effectiveness of three different medications on reducing blood pressure, Mauchly's Test of Sphericity could be used to determine if the variances of blood pressure measurements between the three groups are equal. If the test shows that the assumption of sphericity is violated, it may be necessary to use a different statistical test that does not assume equal variances, such as the Kruskal-Wallis test.

## Mauchly's Test of Sphericity: Definition & Example

**Mauchly's test of sphericity is used to test whether or not the assumption of sphericity is met in a repeated measures ANOVA.**

**Sphericity refers to the condition where the variances of the differences between all combinations of related groups are equal.**

**If this assumption is violated, then the F-ratio becomes inflated and the results of the repeated measures ANOVA become unreliable.**

## How to Perform Mauchly's Test of Sphericity

**Mauchly's test of sphericity uses the following null and alternative hypotheses:**

**H0: The variances of the differences are equalHA: The variances of the differences are *not* equal**

**If the p-value of the test is less than some significance level (e.g. $\alpha = .05$) then we reject the null hypothesis and conclude that the variances of the differences are not equal.**

**Otherwise, if the p-value is not less than some significance level (e.g. $\alpha = .05$) then we fail to reject the null hypothesis and conclude that the assumption of sphericity is met.**

**For example, suppose a doctor measures the resting heart rate of subjects during three different time points:**

**One month before starting a training programIn the middle of a training programOne month after a training program**

**He wants to perform a repeated measures ANOVA to**

**see if there is a significant difference in mean resting heart rate across these three time points.**

**The following table shows the results of his data collection:**

| Subject | Heart Rate Before Program | Heart Rate During Program | Heart Rate After Program | Before - During | Before - After | During - After |
|---|---|---|---|---|---|---|
| 1 | 65 | 58 | 60 | 7 | 5 | -2 |
| 2 | 55 | 48 | 49 | 7 | 6 | -1 |
| 3 | 58 | 55 | 55 | 3 | 3 | 0 |
| 4 | 68 | 60 | 64 | 8 | 4 | -4 |
| 5 | 47 | 45 | 45 | 2 | 2 | 0 |
| | | | **Variance:** | 7.3 | 2.5 | 2.8 |



**We can see that the variances of the differences are not all equal.**

**To determine if these differences are statistically significant, we can perform Mauchly's test of sphericity using some statistical software like R, SPSS, Python, etc.**

**Depending on which software you use, the results of the test will look something like this:**

| Within Subjects Effect | Mauchly's W | Chi-Square | df | p-value |
| --- | --- | --- | --- | --- |
| Time | 0.277 | 1.867 | 2 | 0.356 |

**Mauchly's test of sphericity indicates that the assumption of sphericity has not been violated, X2(2) = 1.867, p = .356.**

**What to Do if Sphericity is Violated**

**In scenarios where the p-value is less than .05 and we reject the null hypothesis of Mauchly's test of sphericity, we typically apply a correction to the degrees of freedom used to calculate the F-ratio.**

**There are three corrections we can apply:**

**Huynh-Feldt (least conservative)Greenhouse-GeisserLower-bound (most conservative)**

**Each of these corrections tend to increase the p-values in the output table of the repeated measures ANOVA to account for the fact that the assumption of sphericity is violated.**

**The following tutorials provide additional information**

## on how to perform a Repeated Measures ANOVA: