

# Understanding Repeated Measures ANOVA in Excel: A Step-by-Step Guide

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The [Repeated Measures ANOVA](#) (Analysis of Variance) represents an exceptionally powerful statistical framework designed to rigorously evaluate whether statistically meaningful differences exist among the means of three or more interdependent groups. This technique is indispensable in research contexts where a [within-subjects design](#) is utilized--meaning the very same participants are subjected to multiple conditions or measured across various time points. Crucially, the RM-ANOVA differs fundamentally from the standard One-Way ANOVA because it explicitly accounts for the inherent correlation present between these repeated measurements. By doing so, it effectively isolates and removes the error variance attributed to stable individual differences, significantly enhancing the test's power to detect genuine treatment effects. Although [Microsoft Excel](#) lacks a specific, dedicated function for this analysis, this comprehensive guide details the precise methodology required to execute and correctly interpret a One-Way Repeated Measures ANOVA using specialized tools embedded within the software.

Determining the appropriate application of the Repeated Measures ANOVA is paramount for achieving accurate statistical results. This methodology is mandated whenever the research design involves exposing the identical cohort of subjects to all levels of the independent variable. A classic example involves longitudinal studies, such as measuring a patient's health metrics before, during, and after a specific medical intervention. The primary advantage of employing this design lies in its superior statistical efficiency. By utilizing each subject as their own control, researchers can effectively minimize variability, thereby gaining greater statistical power to identify genuine effects caused by the experimental manipulation. We will meticulously cover the necessary steps: organizing the data into the required format, leveraging the appropriate function within the Excel [Data Analysis ToolPak](#), and finally, interpreting the resulting output with precision to ensure valid conclusions are drawn regarding the experimental hypothesis.

## The Mechanics of Repeated Measures ANOVA

The central statistical principle governing the [Repeated Measures ANOVA](#) is its sophisticated method of partitioning the total variance observed in the dependent variable. In a standard ANOVA model, the total variance is divided into two primary components: the variance between groups (which reflects the influence of the independent variable) and the variance within groups (which traditionally represents error). The repeated measures context introduces an essential third layer of partitioning. The variance categorized as 'within-groups' is further broken down into variance attributable to the specific subject (individual differences) and the remaining, true residual error. This process of isolating and removing the variance associated with subjects is the definitive feature of RM-ANOVA, significantly increasing the test's sensitivity to detect subtle treatment effects compared to its independent-samples counterpart, such as the [One-Way ANOVA](#).

In a formal statistical sense, the RM-ANOVA is designed to test the [null hypothesis](#), which posits that the population means across all experimental conditions are equivalent. The decision to reject

this hypothesis rests on the resulting [p-value](#). If the calculated [p-value](#) is smaller than the predefined alpha level (conventionally set at 0.05), we conclude that sufficient evidence exists to reject the [null hypothesis](#), thereby asserting that at least one pair of condition means differs in a [statistically significant](#) manner. It is crucial to acknowledge the underlying statistical assumptions of the RM-ANOVA, which include the assumption of normality for the difference scores and the critical assumption of [Sphericity](#). [Sphericity](#) requires that the variances of the differences between all possible pairs of within-subject conditions are equal. Since Excel's standard analysis output does not include formal tests for [Sphericity](#) (such as Mauchly's Test), researchers must recognize this theoretical limitation, often necessitating specialized statistical software for high-stakes research, though the Excel method serves as a powerful illustrative and preliminary tool.

For individuals accustomed to advanced statistical packages, executing this specific analysis in Excel requires a conceptual pivot. The key lies in utilizing the "Anova: Two-Factor Without Replication" function found within Excel's [Data Analysis ToolPak](#). Although this function is typically applied to designs involving two independent factors, its mathematical mechanism is perfectly suited for a one-way repeated measures ANOVA. In this specific configuration, the 'Rows' in the analysis represent the subjects (e.g., individual patients), and the 'Columns' represent the various conditions or treatments (e.g., four distinct drugs). Since each subject provides only one data point per condition, there is no meaningful interaction effect to calculate (which would be the case in a "Two-Factor With Replication" model). Therefore, the "Without Replication" model allows us to effectively isolate the effects of the treatments (Columns) while simultaneously controlling for and factoring out the variance introduced by individual differences (Rows).

## Practical Application: The Drug Efficacy Case Study

To demonstrate the utility of the RM-ANOVA, let us examine a typical scenario within pharmaceutical research. A research team is tasked with determining whether four specific drugs--designated Drug A, Drug B, Drug C, and Drug D--result in differing patient reaction times. To maximize internal validity and control for the inherent biological and neurological variability among individuals, the researchers implement a robust within-subjects design. This experimental setup involves selecting five participants and measuring the reaction time of each participant after the sequential administration of all four drugs. Strict protocols, including sufficient washout periods, are followed between trials to completely eliminate potential carryover effects between the drug conditions.

The resulting dataset is inherently interdependent, which is the defining characteristic necessitating the RM-ANOVA. For example, Patient 1's reaction time under Drug A is statistically correlated with their reaction time under Drug B, and so on for all conditions. This interdependency makes the [Repeated Measures ANOVA](#) the only appropriate statistical tool. In this study, the independent variable is the Drug Type, which possesses four distinct levels (A, B, C, D), and the dependent

variable is the measured reaction time, quantified in seconds. The overarching objective is to statistically determine if the variation observed in reaction times across the four drug conditions is large enough, relative to the residual error, to be considered [statistically significant](#). The total sample comprises five unique subjects, generating twenty total data points (calculated as 5 subjects multiplied by 4 conditions).

Before proceeding to the analysis, the data must be rigorously structured to meet Excel's functional requirements. The critical formatting rule for the ANOVA tool is the establishment of a rectangular data matrix: every row must exclusively represent a unique subject, and every column must represent a distinct measurement condition. This precise structure is essential because it informs Excel to treat the subjects as controlled blocks (the 'Row' factor in the output) and the drug conditions as the primary experimental variable of interest (the 'Column' factor). Following this structure ensures that the software can correctly calculate and segregate the variance components, which is the mathematical basis for the repeated measures control.

## Preparing and Structuring Data for Excel Analysis

The initial and most vital stage of the analysis involves the accurate input of raw data into the Excel environment. The spreadsheet structure must strictly conform to the requirements of the "Two-Factor Without Replication" test, ensuring that the repeated nature of the measurements is captured. Specifically, all measured responses belonging to a single subject must be contained within one row, and all measurements corresponding to a specific treatment level must be placed within a single column.

### Step 1: Enter the data.

Input the raw data, detailing the response time (in seconds) for the five patients across the four drug conditions, exactly as illustrated below. It is imperative that the first row contains descriptive text labels for the conditions (Drug 1 through Drug 4) and that the rows are clearly defined, implicitly or explicitly, by patient identifiers (Patient 1 through Patient 5).

	A	B	C	D	E	F	G
1	<b>Patient</b>	<b>Drug 1</b>	<b>Drug 2</b>	<b>Drug 3</b>	<b>Drug 4</b>		
2	Patient 1	30	28	16	34		
3	Patient 2	14	18	10	22		
4	Patient 3	24	20	18	30		
5	Patient 4	38	34	20	44		
6	Patient 5	26	28	14	30		
7							
8							
9							
10							
11							
12							
13							
14							
15							

Data entry precision is paramount; any transposition error or structural misalignment will inevitably invalidate the subsequent statistical calculations. It is important to note that the patient identifiers themselves are not numerical data points used in the calculation, but rather categorical labels for the rows. The ANOVA tool uses these row labels to calculate the variance component uniquely attributable to individual patient differences. This specific variance component is crucial because it is the element that the repeated measures analysis isolates and removes from the total error term, thereby maximizing the sensitivity of the analysis for detecting the true drug effect.

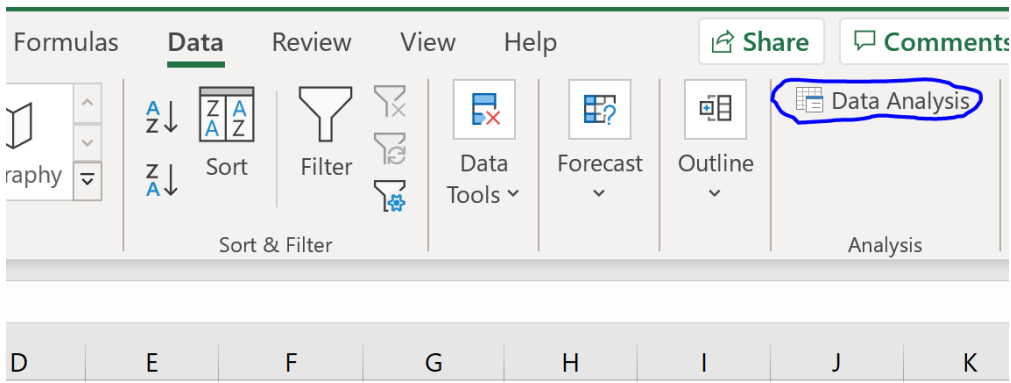
## Executing the Analysis using the Two-Factor Without Replication

### Workaround

Once the data is correctly prepared and structured, the next step is to execute the statistical procedure using the [Data Analysis ToolPak](#). If the "Data Analysis" option is not visible under the Data tab on your Excel ribbon, you must first ensure that the Analysis ToolPak add-in has been successfully loaded and enabled via Excel's options menu. This tool is foundational for executing complex statistical computations within the Microsoft Excel environment.

### Step 2: Perform the repeated measures ANOVA.

Proceed by navigating to the **Data** tab and clicking on the **Data Analysis** button. A dialogue box will subsequently appear, presenting a list of available statistical tests.



From the comprehensive list of options, select **Anova: Two-Factor Without Replication** and confirm your selection by clicking OK. This choice is critical, as it allows for the correct decomposition of variance necessary for a one-way repeated measures design. By employing this function, we treat the subjects as the first factor (Rows) and the treatments as the second factor (Columns), which mathematically implements the control for the subject effect.

	A	B	C	D	E	F	G
1	<b>Patient</b>	<b>Drug 1</b>	<b>Drug 2</b>	<b>Drug 3</b>	<b>Drug 4</b>		
2	Patient 1	30	28	16	34		
3	Patient 2	14	18	10	22		
4	Patient 3	24	20	18	30		
5	Patient 4	38	34	20	44		
6	Patient 5	26	28	14	30		
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**Data Analysis** [?] [X]

Analysis Tools

- Anova: Single Factor
- Anova: Two-Factor With Replication
- Anova: Two-Factor Without Replication**
- Correlation
- Covariance
- Descriptive Statistics
- Exponential Smoothing
- F-Test Two-Sample for Variances
- Fourier Analysis
- Histogram

**Note: The Analysis ToolPak Substitution**

It is absolutely essential to understand that the Excel Analysis Toolpak does not contain an explicitly labeled function for "Repeated Measures ANOVA." However, the output generated by the **Anova: Two-Factor Without Replication** function provides all the necessary statistical metrics--specifically the F-ratio and the [p-value](#)--required to test the treatment effect, provided the input data is structured correctly. This established method is widely adopted as a reliable workaround for researchers conducting preliminary or instructional statistical calculations in Excel.

In the final dialogue box, carefully define the parameters for the analysis. For the **Input Range**, select the entire block of data, ensuring that both the column headers (Drug 1 through Drug 4) and the row labels (Patient 1 through Patient 5) are included. Because the headers are included in the selection, the **Labels** checkbox must be marked. The default **Alpha** value is standardized at 0.05, representing the conventional significance level; this should only be adjusted if a different criterion is scientifically justifiable. Finally, specify a destination for the analysis output within the **Output Range**, selecting a blank, contiguous cell where the comprehensive results table can be generated. After verifying all selections, click **OK** to execute the analysis.

	A	B	C	D	E	F	G	H	I	J	K
1	<b>Patient</b>	<b>Drug 1</b>	<b>Drug 2</b>	<b>Drug 3</b>	<b>Drug 4</b>						
2	Patient 1	30	28	16	34						
3	Patient 2	14	18	10	22						
4	Patient 3	24	20	18	30						
5	Patient 4	38	34	20	44						
6	Patient 5	26	28	14	30						
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Anova: Two-Factor Without Replication

Input Range:

Labels

Alpha:

Output options

Output Range:

New Worksheet Ply:

New Workbook

## Interpreting the Output and Determining Statistical Significance

Once the analysis is completed, the results table will automatically populate in the designated output cell. This detailed table organizes the variance based on its source: Rows (Subjects), Columns (Treatments/Drugs), and Error (Residual). To address our core research question--Does the type of drug administered significantly influence patient reaction time?--our focus must be directed exclusively toward the row labeled **Columns**.

	A	B	C	D	E	F	G	H
1	<b>Patient</b>	<b>Drug 1</b>	<b>Drug 2</b>	<b>Drug 3</b>	<b>Drug 4</b>			
2	Patient 1	30	28	16	34			
3	Patient 2	14	18	10	22			
4	Patient 3	24	20	18	30			
5	Patient 4	38	34	20	44			
6	Patient 5	26	28	14	30			
7								
8	Anova: Two-Factor Without Replication							
9								
10		<i>SUMMARY</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
11		Row 1	4	108	27	60		
12		Row 2	4	64	16	26.66667		
13		Row 3	4	92	23	28		
14		Row 4	4	136	34	104		
15		Row 5	4	98	24.5	51.66667		
16								
17		Column 1	5	132	26.4	76.8		
18		Column 2	5	128	25.6	42.8		
19		Column 3	5	78	15.6	14.8		
20		Column 4	5	160	32	64		
21								
22								
23		ANOVA						
24		<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
25		Rows	680.8	4	170.2	18.10638	5.07E-05	3.259167
26		Columns	698.2	3	232.7333	24.75887	1.99E-05	3.490295
27		Error	112.8	12	9.4			
28								
29		Total	1491.8	19				
30								

The statistical output provides several critical metrics for each source of variation: the Sum of Squares (SS), Degrees of Freedom (df), Mean Square (MS), the [F test-statistic](#), and the P-value. The "Rows" row quantifies the variance associated with individual patient differences. While this component confirms the rationale for using a repeated measures design, it is not the effect being tested. The "Columns" row, conversely, quantifies the variance directly attributable to the different drug treatments. The corresponding [F test-statistic](#) for the Columns represents the ratio of the variance between the drugs to the residual error variance, forming the basis for our inferential conclusion.

In this specific case study, concentrating on the Columns row, we observe that the calculated [F test-statistic](#) is **24.75887**. Corresponding to this F-value is the [p-value](#), which is extremely small: **0.0000199**. To determine if the drug effect is [statistically significant](#), we compare this [p-value](#) against our predefined alpha level of 0.05. Since 0.0000199 is substantially less than 0.05, we possess robust evidence to formally reject the [null hypothesis](#). The firm conclusion drawn from this

analysis is that a [statistically significant](#) difference in mean response times exists among the four drugs tested in the study. Conversely, had the p-value been greater than 0.05, we would have failed to reject the null hypothesis, concluding that the observed differences were most likely attributable to random chance or sampling error.

## Formal Reporting of Results (APA Format)

The concluding phase of any rigorous statistical analysis involves summarizing and formally documenting the findings in a clear, standardized manner, typically following the stringent guidelines established by the American Psychological Association (APA). Reporting the results of a Repeated Measures ANOVA necessitates specifying the experimental design, citing the essential statistical metrics (F-ratio, both degrees of freedom, and the p-value), and stating the final conclusion regarding the [null hypothesis](#).

### Step 3: Report the results.

When presenting the results, researchers must clearly articulate the specific type of test performed, the size of the sample (number of subjects), the independent variable (drug type), and the dependent variable (response time). The formal statistical notation requires the F-statistic, immediately followed by the two degrees of freedom enclosed in parentheses--the degrees of freedom for the effect (Columns) and the degrees of freedom for the error (Residual)--and finally, the precise p-value or a threshold indication.

A one-way repeated measures ANOVA was conducted on 5 participants to rigorously examine the effect of four distinct drug conditions on patient response time.

Results indicated that the type of drug administered led to [statistically significant differences](#) in response time ( $F(3, 12) = 24.76, p < 0.001$ ). This significant finding confirms that the mean reaction times are not statistically equivalent across all four drug conditions. Further, detailed post-hoc analysis would be required to determine precisely which specific pairs of drugs yield a [statistically significant difference](#) in efficacy.

It is standard practice in formal APA reporting to round the F-statistic to two decimal places (24.76). When the p-value is extremely small, it is often reported as being less than the minimum significance threshold (e.g.,  $p < 0.001$ ) rather than stating the exact value derived from the output. The degrees of freedom--df for Columns (3) and df for Error (12)--are derived directly from the Excel output table. This structured and standardized reporting concludes the analysis of the repeated measures data in Excel, ensuring transparency and adherence to professional scientific standards.