



ANOVA Test

Stats Project



Purpose & Why it's needed

- ANOVA (Analysis of Variance)
- A way to find out if the results of a survey or experiment are significant
- Compare the means of two or more groups
- Helps resolve the need to reject a null hypothesis or accept an alternate hypothesis
- See whether the independent variable causes effect, or just randomness
- Form of statistical hypothesis testing

Assumptions

- Assumption #1: Continuous dependent variable
- Assumption #2: Two or more levels in the IV
- Assumption #3: Independence of Observations
- Assumption #4: No significant outliers
- Assumption #5: Dependent variable is normally distributed
- Assumption #6: Homogeneity of Variances

General Terminology

- Null Hypothesis - No significant differences among groups, and changes are caused only by randomness
- Alternate Hypothesis - Assumes at least one significant difference among the groups, and changes are caused by the IVs
- P value - Area under bell curve that is right of the 2nd variance
- Levels - Different independent variables

Conditions of Use

One Way ANOVA Test

- One independent variable
- Two levels

Two Way ANOVA Test

- Two independent variables
- Multiple levels

Manova Test

- Multiple Dependent variables
- One way vs. Two Way

Procedure & Math (Overview)

- Antidepressant efficacy
- 3 Levels (2 Experimental + Control)
- IV: Treatment Type
- DV: Beck Depression Inventory Score (Score ↑ = Depression ↑)
- One-Way ANOVA (1 IV, 1 DV)

| <u>Placebo</u> | <u>Low Dose</u> | <u>Moderate Dose</u> |
|----------------|-----------------|----------------------|
| 38 | 22 | 14 |
| 47 | 19 | 26 |
| 39 | 8 | 11 |
| 25 | 23 | 18 |
| 42 | 31 | 5 |

Analysis of Variance Results

F-statistic value = 11.26657

P-value = 0.00176

Critical F-Value: 6.93
(F_(2,12) for p = 0.01)

| Data Summary | | | | |
|--------------|---|------|-----------|------------|
| Groups | N | Mean | Std. Dev. | Std. Error |
| Group 1 | 5 | 38.2 | 8.167 | 3.6524 |
| Group 2 | 5 | 20.6 | 8.3247 | 3.7229 |
| Group 3 | 5 | 14.8 | 7.8549 | 3.5128 |

| ANOVA Summary | | | | |
|----------------|--------------------------|----------------------|-------------------|-------------------|
| Source | Degrees of Freedom DF | Sum of Squares SS | Mean Square MS | F-Stat P-Value |
| Between Groups | 2 | 21484.9333 | 3742.4667 | 411.26660.0018 |
| Within Groups | 12 | 790.7999 | 365.9 | |
| Total: | 14 | 2275.7332 | | |

Interpret the Test

- F-statistic is calculated
- Represents ratio of SSB to SSW
- Larger the number represents more difference between groups
- Small number represents more variance in a group
- Tells you if the independent variable is causing significant change
- Significance test also needs to be conducted

How to Present

- APA format for reporting an ANOVA test
- You have to report IV, DV, degrees of freedom, F stat and P Value
- Reporting goes in Results Section
- Interpretation goes in Discussion or Conclusion
- “There was a significant (not a significant) effect of IV _____ on DV _____ at the $p < .05$ level for the three conditions [$F(____, ____)$] = _____, $p = _____$ ”
- If significant Results are found, have to conduct a post hoc test
 - Post Hoc - Explores differences between multiple group means
- Helps find where the condition had effect

Use in a Journal Article

- ANOVA *Analysis of Student Daily Test Scores in Multi-Day Test Periods*
- Link: <https://eric.ed.gov/?id=EJ1139744>

IV: Test day (Out of a 4-day exam block)

DV: Test score

Controls: Cumulative GPA

of Tests Taken

EXHIBIT 4
MEAN TEST PERCENT SCORE
ANOVA RESULTS AND BROWN FORSYTH FOR NON-HOMOGENEITY OF VARIANCE

Descriptives

| Day | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | |
|-------|------|---------|----------------|------------|----------------------------------|-------------|
| | | | | | Lower Bound | Upper Bound |
| 1 | 174 | .851935 | .1332764 | .0101037 | .831993 | .871877 |
| 2 | 207 | .822888 | .1571310 | .0109214 | .801356 | .844420 |
| 3 | 338 | .799901 | .1418721 | .0077168 | .784722 | .815080 |
| 4 | 738 | .713808 | .1708646 | .0062896 | .701460 | .726155 |
| Total | 1457 | .765773 | .1674227 | .0043862 | .757169 | .774377 |

ANOVA

| | Sum of Squares | df | Mean Square | F | Sig. |
|----------------|----------------|------|-------------|--------|------|
| Between Groups | 4.354 | 3 | 1.451 | 57.835 | .000 |
| Within Groups | 36.459 | 1453 | .025 | | |
| Total | 40.812 | 1456 | | | |

Interpretation of Journal Data

“There was a significant effect of test day on test scores at the $p < .05$ level for the three conditions [$F(3, 1453) = 113.07, p = .000$]”

To Note:

- Post-hoc tests required to determine specific effect
- ($p = .000$) is APA format to report ($p < 0.001$)

ANOVA Test (Analysis of Variance)

Purpose & Use?

The ANOVA tests are used to analyze differences among multiple different groups. This analysis of variance between and in groups helps to determine whether the independent variable affected the different groups, and reject the null hypothesis, or if no effect occurred.

How to Take the Test

After An Experiment:

1. Find Overall Variability(Sum of Square Total)
2. Find Variability Within a Group(SSW)
3. Find Variability Between Groups(SSB)
4. Ratio of SSW to SSB shows Significance(F Statistic)

Interpretation

$F_{Statistic}$

- ▲ 1 Significant differences
1 between groups
- ▼ 1 No Significant differences
1 between groups

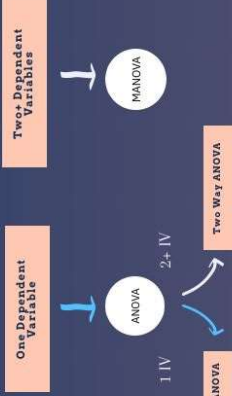
If the F statistic is Greater than 1, then the variance between groups is larger than just the variance in groups. This number signifies that the independent variable did cause a significant change in the data.

Presentation

When the ANOVA test result is presented the degrees of freedom, F value, and significance value(p) need to be reported, with the interpretation of significance. The statistic should be presented in the results section but interpreted in the discussion or conclusions sections.

Conditions

ANOVA tests can be used on the results of almost all experiments.



Basic Assumptions:

- Normal Population Distribution
- Same Variance in Population
- Data is independent between groups

Example Dataset

| | Control | Group 1 | Group 2 |
|--|---------|---------|---------|
| | 38 | 22 | 14 |
| | 47 | 19 | 26 |
| | 39 | 8 | 11 |
| | 25 | 23 | 18 |
| | 42 | 31 | 5 |

One Way ANOVA Test

- 2 levels
- 1 IV
- 1 DV

SST = 2275.7332
SSB = 1484.933
SSW = 790.799
SSB > SSW

F stat=11.726657

F stat > 1.0

The independent variable has significant effect on the dependent variable. The null hypothesis can be rejected

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