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ANOVA Test in Pharmaceutical Analysis

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Abstract: *Healthcare Industry is the largest sector in India which comprises hospitals, pharmaceuticals, diagnostics, telemedicine, medical tourism, and so on. Here in this paper, a few applications of ANOVA in the field of pharmaceutical and other health services are discussed. If the number of Samples is more than two, the z-test and t-test cannot be used. The technic of variance analysis developed by Fisher is very useful in such cases and with the help of this, it is possible to study the significance of mean values of a large no. of samples at the same time.*

Keywords: Sampling, Hypothesis testing, Variance, Standard Deviation, Coefficient of Variance, Consistency

I. Introduction

Means are generally considered as the only criteria for comparing the consistency which is not true. As higher the mean does not necessarily mean, higher will be the consistency. An ANOVA test is a way to find out if survey or experiment results are significant. In other words, they help you to figure out if you need to reject the null hypothesis or accept the alternate hypothesis. Analysis of variance (ANOVA) is a statistical procedure concerned with comparing the means of several samples. It can be thought of as an extension of the t-test for two independent samples to more than two groups. The purpose is to test for significant differences between class means, and this is done by the analysis of the variances. When performing an ANOVA procedure the following assumptions are required:

- The observations are independent of one another.
- The observations in each group come from a normal distribution.
- The population variances in each group are the same.

ANOVA is the most commonly quoted advanced research method in the professional business and economic literature. This technique is very useful in revealing important information particularly in interpreting experimental outcomes and in determining the influence of some factors on other processing parameters. The original ideas of analysis of variance were developed by the English statistician Sir Ronald A. Fisher (1890-1962) in his book "Statistical Methods for Research Workers" (1925). Much of the early work in this area dealt with agricultural experiments.

EXAMPLES:

You're testing groups to see if there's a difference between them. Examples of when you might want to test different groups:

- A group of psychiatric patients is trying three different therapies: counselling, medication, and biofeedback. You want to see if one therapy is better than the others.
- A manufacturer has two different processes to make light bulbs. They want to know if one process is better than the other.
- Students from different colleges take the same exam. You want to see if one college outperforms the other.

TYPES:

There are two main types: one-way and two-way. Two-way tests can be with or without replication.

- One-way ANOVA between groups: used when you want to test two groups to see if there's a difference between them.
- Two-way ANOVA without replication: used when you have one group and you're doubletesting that same group. For example, you're testing one set of individuals before and after they take medication to see if it works or not.

- Two-way ANOVA with replication: Two groups and the members of those groups are doing more than one thing. For example, two groups of patients from different hospitals tried two different therapies.

II. EXPLANATION

2.1 Selecting Data

The Beck Depression Inventory (BDI, BDI-1A, BDI-II), created by Aaron T. Beck, is a 21-question multiple-choice self-report inventory, one of the most widely used psychometric tests for measuring the severity of depression.

Score on Beck's Depression Inventory						
	gender					
	Male			Female		
Medicine administered	N	Mean	Std. Deviation	N	Mean	Std. Deviation
None	12	37.33	5.263	13	45.77	4.206
Placebo	10	30.80	6.460	15	37.87	6.093
Homeopathic	14	34.07	7.119	11	37.36	5.749
Pharmaceutical	10	29.30	5.579	15	25.27	7.076
Total	46	33.17	6.741	54	36.17	9.520

Note that this table shows the 8 means (2 genders * 4 medicines) that our analysis is all about. Each of these 8 means is based on 10 through 15 observations so the sample sizes are roughly equal. This means that we don't need to bother about the homogeneity assumption.

III. PROCEDURE

3.1 Definition

- Data: The collection of information regarding certain variants.
- Mean: The average of the given values in data. It is given by the sum of all the values divided by the total observations
- Standard Deviations (S.D): The square root of the mean of the squares of the deviations of all the values from their mean is called S.D.
- Variance (V): The Square of S.D. is called variance.
- Coefficient of Variance (C.V): The percentage ratios of S.D. with mean is called the coefficient of variance or variability

3.2 Equations/Formulae

The various formulae required are:

- Mean $m = \frac{\sum x}{N}$
- Variance is $V = \frac{\sum x^2}{N} - m^2$
- S.D. $\sigma = \sqrt{V}$
- Coefficient of Variance $C.V. = \frac{\sigma}{m} \times 100$
- If the C.V. of a data is less than the other then it is said to be more consistent and conversely
- i.e.. The Consistency is inversely proportional to variability.

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3.3 Illustration

Suppose there are two groups of data viz data-A and data-B. The values/entries in data-A are $x_1, x_2, x_3, \ldots x_n$ and the same in data-B are $y_1, y_2, y_3, \ldots y_n$ for total 'n' number of observations.

Step-1: Find the mean of both the data: i.e. $m = \frac{\sum x_i}{n}$ and $m' = \frac{\sum y_i}{n}$

Step-2: Find the S.D. of both the data: $\sigma = \sqrt{\frac{\sum x_i^2}{N} - m^2}$ and $\sigma' = \sqrt{\frac{\sum y_i^2}{N} - m^2}$

Step-3: Calculate the Coefficient of variance of both.

i.e. C.V. of data-A, $V_A = \frac{\sigma}{m} \times 100$ and C.V. of data-B, $V_B = \frac{\sigma'}{m'} \times 100$

Step-4: Compare both the C.V.s.

1) If $V_B < V_C$ then data-A is said to be more consistent.

2) If $V_C < V_B$ then data-B is said to be more consistent

IV. APPLICATION/ADVANTAGES

- Similar to t-test
- More versatile than the t-test
- ANOVA is the synthesis of several ideas and it is used for multiple purposes.
- The Statistical Analysis depends on the design and discussion of ANOVA, therefore includes common statistical designs used in pharmaceutical research.
- In the bioequivalence, studies the similarities between the samples will be analyzed with ANOVA only.
- Pharmacodynamics (what drugs does to the body) data also will be analyzed with ANOVA only. i.e. We can analyze a drug is showing a significant pharmacological action or not.
- Compare heights of plants with or without galls.
- Compare birth weights of Deer in different geographical regions.
- Compare attention spans of undergraduate students in different programs.

V. CALCULATION

For the above- table,

For Men:

$$C.V. = \frac{\sigma}{m} \times 100$$

$$C.V. = \frac{6.741}{33.17} \times 100$$

C. V. = 20.32%

For Women:

$$C.V. = \frac{\sigma}{m} \times 100$$

$$C.V. = \frac{9.520}{36.17} \times 100$$

C. V. = 26.32%

Thus C.V. of Men is less than that of Women, which means the BDI score of men is more consistent than that of women.

VI. Conclusion

In many statistical applications in business administration, psychology, social science, medical and health care, we need to compare more than two groups. For hypothesis testing more than two populations, the ANOVA test is used. The Above test procedure compares the variation in observations between samples to the variation within samples. The analysis of variance assumes that the observations are normally and independently distributed with the same variance for each treatment.

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