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WHAT DOES A 'P'-VALUE TELLS YOU ABOUT STATISTICS?- A REVIEW.

Jibi Joseph¹, *Bathala Lakshmana Rao², TLG Sravanthi³, PK Monika⁴, G.M. Vathsalya⁵

1. Sr.Lecturer, Department of prosthodontics, College of Dental Sciences & Hospital, Indore.
2. Professor & Head, Department of prosthodontics, Lenora institute of dental sciences, Rajahmundry, A.P
3. Postgraduate student, Department of prosthodontics, Lenora institute of dental sciences, Rajahmundry, A.P
4. Postgraduate student, Department of prosthodontics, Lenora institute of dental sciences, Department of prosthodontics, Lenora institute of dental sciences, Rajahmundry, A.P
5. Sr.Lecturer, Department of prosthodontics, Lenora institute of dental sciences, Department of prosthodontics, Lenora institute of dental sciences, Rajahmundry, A.P

ABSTRACT

Statistical significance is often wrongly used as a standard for assessing the importance of the effect measured. There is a long history of this profession and is a result of the need for an unbiased way of expressing significance. The most important link between the population and its characteristics, allowing us to draw population inferences based on sample observations, depends on the distribution of probabilities. P-value remains an area of confusion for many. Since there are very little literature available explaining probability value and its importance in statistics, this article aims to explain P-value, its significance, and how to calculate it in a simpler and easier way.

Key Words: P-value; Low P-value; Hypothesis; Type-1 error.

INTRODUCTION

The distribution of probabilities is a way of enumerating the various values that the variable may have, and how often each value occurs in the population. The real distribution of frequencies is approximated to a theoretical curve used as a distribution of probability. Binomial and Normal are common examples of a probability distribution.¹ One of these three common probability distributions is used in health research for most statistical analyses.¹ Since there are very little literature available explaining probability value and its importance in statistics, this article aims to explain about P-value, its significance, and how to calculate it in a simpler and easier way.

WHAT IS P – VALUE?

P-value was first introduced by Karl Pearson in his Pearson's chi-squared test.²

In statistics, the p-value is the probability of obtaining results as extreme as the observed results of a statistical hypothesis test, assuming that the null hypothesis is correct. The p-value is used as an alternative to rejection points to provide the smallest level of significance at which the null hypothesis would be rejected.³

P-value is defined as the probability of obtaining a result equal to or more extreme than what was observed. If the value of P is large, the probability is lower and the value of P is lower, it denotes a higher probability of occurrence.⁴

P values are often misunderstood and give no evidence in the study of the quantitative significance of the effect. P-value states that the results were due to chance but not true. However, the chances of errors are bigger. The misuse of P-value leads to misconceptions and interpretations. P-value awareness and understanding can diminish misinterpretations.⁵

P-value represents in a specific mathematical model the inconsistency of reality, but it does not provide any proof on the hypothesis. The P-value does not measure the impact size, or the importance of a finding and the results of the analysis cannot be based on P values because it does not measure the likelihood.²

CONFUSING P – VALUE?

The most popular statistical error in prosthodontic literature is confusing P value with clinical significance. Since there is no significant information on the effect size and clinical significance of the observed effect, it should be regarded as insufficient evidence against the hypothesis, rather than no effect.⁶

A key observation of a quantitative study is the effect size. Whereas a P value may provide the on-effect existence information, it doesn't disclose the effect size. The P value and the size of the effect help to explain the analysis in detail. Thinking beyond P values and recording the effect size parameters is important to enhance the impact of the study.⁷

HOW TO CALCULATE P – VALUE

P-values are measured using p-value tables or statistical applications / spreadsheets. Because different researchers use different levels of significance when examining a question, it can be difficult for a reader to compare results from two different tests at times. This problem is solved by P-values.⁸

CUT OFF FOR P - VALUE

RA Fisher illustrated the rationale for using 0.05, or 5% as the cut off for considering the outcome of an experiment. In his experiment he asked a British woman to identify the cup with milk poured into the tea among the 8 cups. This woman claimed to have the ability to identify if milk or tea was poured into the cup first. Fisher's analysis began with the null hypothesis that the woman had no such ability. If the woman did not have her claimed ability, then she would have had only 1 in 70 or 1.4% chance of being right for all 8 cups. If, and only if, the woman could correctly identify the correct preparations of all the cups did Fisher concede that the null hypothesis had to be rejected. As the story goes, she successfully identified the cups. Since its initial description, however, "signify" has become "significant," and P values have—incorrectly—become synonymous with "important".⁹

P - VALUE APPROACH TO HYPOTHESIS TESTING

The p-value hypothesis testing approach uses the calculated probability to determine whether there is evidence to

dismiss the null hypothesis. The null hypothesis, also known as the conjecture, is the initial argument concerning a population (or method of generating data). The alternative hypothesis states whether the parameter of the population differs from the value of the population parameter in the conjecture.⁸

Type 1 error - An error with type I is a false rejection of the null hypothesis. This happens when in fact the null hypothesis is valid, but the null hypothesis is dismissed, having a p-value lower than the point of significance (often 0.05). The probability of an error of form I is the meaning level (again, sometimes 0.05), which is the relative frequency of occurrence of having a p-value that is less than the meaning level, assuming the null hypothesis is correct.⁸

Type 2 error – stating no difference when actually there is that is missing a true difference. Occurs when sample size is too small. Probability (Type 2 error) – β . Conventionally accepted to be 0.1 – 0.2. power of a study = $(1 - \beta)$. Researchers consider a power 0.8 – 0.9 (80 – 90%) as satisfactory.⁸

LOW / HIGH P – VALUE

Low p value - if p is very small (<0.001), then the null hypothesis appears not realistic because the difference could hardly ever arise due to chance, when the null hypothesis is true or low p – value indicates low probability to get the observed result due to chance.¹

High p value - if p is large (>0.001), it indicates high probability to get the observed result due to chance. It favors null hypothesis.¹

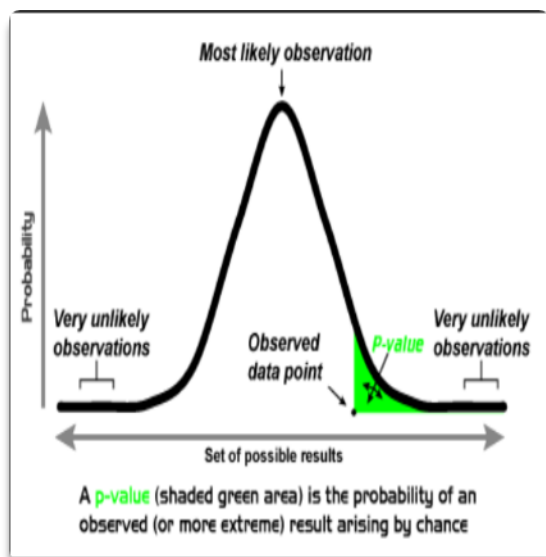


Figure – 1 (p – value)

CONCLUSION

Data are contextual details. Insist on a detailed explanation of the context of a research. A P value is determined from a number set embedded in some assumptions. Viewed alone, the P value can be irrelevant, and your evaluation of the arguments made in a research article limits its usefulness.¹⁰

Good statistical practice, as an integral component of good science practice, emphasizes principles of good research design and behavior, a range of numerical and graphical data summaries, understanding of the phenomenon under analysis, explanation of findings in context, detailed reporting and a clear logical and quantitative understanding of what data summaries mean.

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