Review Article

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Biostatistics in Dentistry

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Abstract

Statistics can be useful in every stage of practice. It may be with regard to materials being used, patients treated and for research purpose testing the efficacy of a certain treatment method. Statistical tests are not universal. Specific statistical test should be applied for specific purpose. This article discusses about what is statistics and various statistical tests used in dentistry.

Keywords: Biostatistics; P-Value; Tests.

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Introduction

The Merriam-Webster's Collegiate Dictionary definition is: "A branch of mathematics dealing with the collection, analysis, interpretation, and presentation of masses of numerical data." The steps of statistical analysis involve collecting information, evaluating it, and drawing conclusions. Statistics is the science and art of dealing with variation of data in order to obtain reliable results and conclusions „. Biostatistics is the application of statistics to problems in the biological sciences, health, and medicine [1,2].

Biostatistics is used to determine how diseases develop, progress and spread. For example, biostatisticians use statistics to predict the behavior of an illness like the flu. It's used to help predict the mortality rate, the symptoms and even the time of year people might get it [3]. Another well known uses of biostatistics in epidemiology, was in research for the development of the polio vaccine in the 1950s. Readers of the dental literature will often find articles that attempt to show that one particular therapy is more effective than another, but statistics can also demonstrate when there is a relationship between two or more variables [6].

Types of Data [7]

1. Categorical data

   A. Binary data (subset of categorical data)
2. Ordinal data
3. Quantitative data

Uses of Statistics

1. To promote health legislation and in creating administrative standards
2. To determine success or failure of specific oral health care programs or to evaluate the program action
3. To indicate the basic factors underlying the state of oral health by diagnosing the community and solutions
4. To assess the state of oral health in the community and to determine the availability and utilization of dental care facilities

Steps in a Research Project

In practice, every **research project** or study involves the following **steps**.

1. Planning/design of study
2. Data collection
3. Data analysis
4. Presentation
5. Interpretation

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p-Value : The P-value is the probability of obtaining the sample results if the null hypothesis, that there is 'no effect' in the population, is true.

p-Value is the probability of observing the difference or a greater difference when there is in fact no difference. The p-value measures consistency between the results actually obtained in the trial and the "pure chance" explanation for those results. In theory, the P value is a continuous measure of evidence, but in practice it is typically trichotomized approximately into strong evidence, weak evidence,

Table 1: Selecting proper statistical tests

Q1, difference/ correlation	Q2, paired/repeated	Q3 and Q4, type of outcome (normality)	Q5, no. of groups	Valid tests
Difference	Independent (unpaired)	Continuous (normal)	2	Student s t-test
			>2	One-way ANOVA
		Continuous (non-normal)/ordered categorical	2	Mann Whitney U test
			>2	Kruskal Wallis H test
		Nominal	2	Fisher s exact test
			>2	Chi-square test
			2	Log-rank test (Kaplan Meier plot)
	Dependent (paired)	Continuous (normal)	2	Paired t-test
			2	Repeated measured ANOVA Mixed effect regression
		Continuous (non-normal)/ordered categorical	2	Wilcoxon signed-rank test
			>2	Friedman test
		Nominal	2	McNemar s test
Correlation		Continuous (normal)		Pearson s correlation (r)
		Continuous (non-normal)/ordered		Spearman s correlation (rs)
		Nominal (two levels)	2	Spearman/Kappa (agreement)

Table 2: Comparison of Means: look for the difference between the means of variables

Paired T-test	Tests for the difference between two related variables. When the means being compared come from observations that are naturally paired or matched **Ex.** Before vs after studies, also called longitudinal studies produce paired data. Each patient contributes two paired observations: the before value and the after value.
Independent T-test	Tests for the difference between two independent variables. The independent-samples t test evaluates the difference between the means of two independent or unrelated groups. That is, we evaluate whether the means for two independent groups are significantly different from each other.
ANOVA	Tests the difference between group means **after** any other variance in the outcome variable is accounted for. The ANOVA method assesses the relative size of variance among group means (between group variance) compared to the average variance within groups (within group variance).[5]
The Mann-Whitney U test	appropriate test for ordinal data on two independent groups. The non-parametric Mann-Whitney U tests differences in rank order, whereas the t-test examines differences in means. The Mann-Whitney U test was not done as, in general, it is easier to obtain statistical significance with a parametric test, such as a t-test, as compared with a non-parametric test. [10]
Z Test	A Z-test is a type of hypothesis test. Hypothesis testing is just a way for you to figure out if results from a test are valid or repeatable. For example, if someone said they had found a new drug that cures cancer, you would want to be sure it was probably true. A hypothesis test will tell you if it's probably true, or probably not true. A Z test, is used when your data is approximately normally distributed.

and no evidence (these can also be labeled highly significant, marginally significant, and not statistically significant at conventional levels), with cutoffs roughly at P = 0.01 and 0.10 [4]. A relationship exists between P-values, confidence intervals and the null value.[7] The confidence interval is a range of values calculated by statistical methods which includes the desired true parameter (for example, the arithmetic mean, the difference between two means, the odds ratio etc.) with a probability defined in advance (coverage probability, confidence probability, or confidence level). The confidence level of 95% is usually selected [11].

Statistical Significance

An effect is statistically significant if the null hypothesis is rejected, usually if $P < 0.05$. Until relatively recently statistical results in published medical and dental papers tended to report in terms of significance levels (eg $0.01 < P < 0.05$ or $0.001 < P < 0.01$), the modern trend is to quote exact *P*-values (eg $P = 0.03$ or $P = 0.007$) and concentrate on 95% confidence intervals [12].

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Z Test A Z-test is a type of hypothesis test. Hypothesis testing is just a way for you to figure out if results from a test are valid or repeatable. For example, if someone said they had found a new drug that cures cancer, you would want to be sure it was probably true. A hypothesis test will tell you if it's probably true, or probably not true. A Z test, is used when your data is approximately normally distributed.

Conclusion

The understanding of biostatistics is very important to get a validated result of the study. Every step of the research from study design, sample size, p values to application of statistical tests should be done diligently to avoid any bias that might affect the outcome of the research. This article is yet another attempt to guide the research person.

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