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TIPS FOR AUTHORS

Let's Talk About Statistics and Prosthodontics Research: Part 3, Presentation of Results

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Continuing our look at the role of statistics in prosthodontics research, in this issue we'll offer some guidelines for the presentation of results from statistical analyses. We'll start with general guidelines for the reporting of descriptive statistics, followed by more specific guidelines for a few different types of analyses. We'll conclude with suggestions for further reading.

Statistical methods

Statistical methods should be described with enough detail to enable a knowledgeable reader with access to the original data to verify the reported results.[1] This information should be presented at the end of the Materials and Methods section.

Descriptive statistics

When simply describing a set of continuous data, useful statistics to include are the number of observations, units of measurement, a measure of central tendency (such as the mean, median or mode), and a measure of the variation or scatter, e.g., standard deviation (SD), range or interquantile range. The mean and standard deviation are used to describe data that are approximately normally distributed; in non-normal distributions, the data should be summarized with the median and range or interquantile range. The standard error of the mean (SEM) is not a descriptive statistic and should not be used as such. When summarizing data graphically, it may be more informative to show the individual data points using a scatter plot, histogram, or box plot rather than simply a bar chart of the means.

Reporting the result of a test of a hypothesis

Too often the result of a hypothesis test is summarized solely in terms of the p-value. The common simple statements of "$p < 0.05$," "$p > 0.05$," or "$p = \text{NS}$" provide little information about a study's findings and rely on the arbitrary convention of the 0.05 level of statistical significance. In addition, reporting the actual p-value (e.g., $p = 0.56$) provides little information about the size of the difference observed. Most statisticians recommend that researchers summarize findings using point estimates and confidence intervals (CI). For example, the statistical comparison between two group means can be summarized by reporting their mean difference and the 95% CI for the mean difference. It's important to remember that statistical significance is not synonymous with clinical significance or biological relevance and that the term "significant" should be avoided unless it is used to refer specifically to statistical significance.

Reporting the relationship between two continuous variables

A particular study objective might be to evaluate the relationship between two continuous variables. If the researcher is interested in the "strength" of the relationship, then it is appropriate to report the value and type of correlation coefficient along with a scatter plot. Typically, the Pearson's correlation coefficient is reported. If one of the variables is not normally distributed, however, and the distribution cannot be improved by applying a transformation, then the Spearman's rank correlation coefficient is often used. On the other hand, if the researcher is interested in the "nature" of the relationship, and the relationship is reasonably approximated by a straight line, then the results of a linear regression analysis should be reported. If the purpose of the regression analysis is hypothesis testing, then the regression coefficient and corresponding 95% CI should be reported for the predictor or explanatory variable. If the purpose of the regression analysis is prediction, then the equation of the linear regression and coefficient of determination should be presented.

Reporting multifactorial analyses

A common study design in dental research involves assessing the effect of one or more variables or factors on a continuous response variable, such as assessing the effect of bonding agent

and cement type on shear bond strength. In the case of one factor with more than two levels and a normally distributed response variable, the data should be evaluated using one-way analysis of variance (ANOVA). The mean response (and SD) should be reported for each of the factor levels along with the *p*-value for the overall comparison between levels; however, if the overall comparison does not attain statistical significance, pairwise comparisons of the factor levels should not be performed unless they were determined to be of primary interest in advance. In the case of two factors, the data should be analyzed using two-way ANOVA. The researcher needs to report whether the factors were first tested for interaction and how the interaction was handled. Two factors are said to interact if the effect of one factor on the response variable depends on the level of the other factor. In the absence of a statistically significant interaction, the researcher can report the results for each factor separately as described above for a one-way ANOVA.

Reporting time-to-an-event analyses

A particular study objective might be to follow patients with dental implants over a period of time to assess whether the implants failed (i.e., developed an "event" of interest) and to identify factors associated with failure. Since the follow-up period can be expected to vary per implant, and failure will not have occurred for all implants, specific statistical methodologies such as the Kaplan–Meier method and the Cox proportional hazards regression analysis should be used. When describing study results it is important to report the following information: the starting point of the time interval (e.g., date of placement), definition of failure, reasons for censoring (e.g., ending follow-up), the median or mean duration of follow-up (overall and among those without the event), and the Kaplan–Meier estimates at specific time points (e.g., 1 year after placement). The Kaplan–Meier estimates can be summarized by displaying the estimates on a curve over time. Since the precision of these estimates is dependent on the number of implants with follow-up, it is recommended that the curves be halted at a particular time point when there are no fewer than 10 implants still being followed and therefore at risk for failure, or for a large sample, no less than 10% of the implants still at risk.[2] The results from the Cox regression analysis should be summarized by reporting the hazard ratio and corresponding 95% CI.

Additional reading

A number of useful textbooks dedicated to statistical reporting are available. Two recent books by Lang and Secic[3] and Peacock and Kerry[4] are useful resources. In an effort to improve the reporting quality of research, the Consolidated Standards of Reporting Trials (CONSORT) statement has been developed for randomized trials.[5] Similarly, The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Initiative provides recommendations on what should be included in an accurate and complete report of an observational study, with guidelines and checklists specific to cohort studies, case-control studies, and cross-sectional studies.[6,7] Both the STROBE report and the CONSORT statement have also been published in Spanish and German in addition to several English language journals other than those listed here. The CONSORT statement has also been published in Chinese.

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