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Editorial

How to Minimize Common Biostatistical Errors in Clinical Research

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Biostatistics is essential for developing, interpreting, and drawing conclusions from clinical, biological, and epidemiological data. However, incorrect application of biostatistical methods can compromise the validity and reliability of study findings, leading to erroneous conclusions and misguided clinical practices. Clinicians and researchers must understand these pitfalls to ensure robust study design, accurate analysis, and meaningful interpretation of results. Many health researchers lack substantial biostatistical training and often do not collaborate with experts, leading to frequent errors in data analysis and presentation in published studies. Misusing biostatistics in health research is unethical and can result in severe clinical consequences, including incorrect conclusions, compromised study validity, and inaccurate treatment effect estimates (1,2). This editorial outlines the most frequent mistakes encountered in the biostatistical analysis process and offers tips to minimize these errors.

Many readers believe journal articles undergo thorough scrutiny by reviewers and editors, including a detailed examination of the biostatistical methods. However, this is often not the case. Common biostatistics errors includes: primary outcome measures are either not clearly stated or are ambiguous, no prior calculation of sample size or estimation of effect size, incorrect calculation of sample size, the study sample is not representative of the target population due to the use of inappropriate sampling techniques, use of an inappropriate control group, errors in summarizing data, insufficient graphical or numerical representation of essential data, employing an incorrect metric to describe the data, application of an inappropriate statistical test, using unpaired tests for paired data or vice versa, inappropriate multiple pairwise comparisons among more than two groups, using correlation as a measure of agreement, interpreting correlation as causation, failure to validate the assumptions of the test, inflation of Type I error, neglecting to adjust for multiple comparisons, over-interpreting results especially in small sample size studies, errors related with p-values, failure to use multivariable techniques to adjust for confounding, misunderstanding confounders and mediators, inappropriate interpretation and poor reporting of results, drawing conclusions not supported by the study data, and assuming that clinical significance is the same as statistical significance (1,3–7). These mistakes are well-documented and frequently discussed in numerous articles, yet persist in many journals. Identifying and addressing these errors can help authors, reviewers, and readers avoid them in the future, thereby improving the overall quality of manuscripts. By designing studies carefully and interpreting results within the context of clinical relevance and prior research objectives, we can overcome these pitfalls and ensure the accuracy and reliability of study findings. Raising awareness of these common mistakes will encourage authors and reviewers to be more vigilant, reducing their occurrence in the future (1,4).

While multifaceted statistical software packages make it easier for investigators with limited biostatistical skills to conduct their own data analysis, this can lead to significant problems due to a lack of understanding of the underlying statistical concepts (7). Since society relies on informed judgments supported by statistical methods, all practitioners must work professionally, competently, respectfully, and ethically regardless of their training, occupation, or job title. An ethical statistical practitioner is transparent about the assumptions made during the execution and interpretation of statistical practices, including the methods used, limitations, potential sources of error, and algorithmic biases (8).

Here are some approaches to minimize common biostatistical errors in clinical articles (1,2,5,7,9–11):

- Involve biostatisticians from the early study design phase, as errors at this stage can have significant repercussions, impacting all subsequent stages of health research, including data analysis and interpretation. Their expertise is invaluable in selecting appropriate study designs, calculating sample sizes, and planning analyses that strengthen the study methodology and ensure reliable results.

- Offer continuous training for researchers on biostatistical methods and common pitfalls.
- Utilize standard, reliable, and applicable instruments to evaluate the statistical rigor of manuscripts.
- Perform sensitivity analyses to evaluate the robustness of the study findings.
- Review submitted manuscripts for biostatistical aspects to prevent statistical and interpretation errors.
- Promote collaboration and peer review among multidisciplinary teams, including clinicians, epidemiolo gists, and biostatisticians

Journals play a crucial role in ensuring the quality and reliability of published health research. Since every journal aims to achieve a high scientific impact factor, maintaining research quality is essential. Researchers are responsible for understanding research methods, conducting the best possible studies, and publishing honest and unbiased results. By being aware of common pitfalls, researchers can enhance their studies' validity and contribute to advancing evidence-based medicine. Ultimately, by addressing these common mistakes and implementing the approaches mentioned above, researchers, reviewers, and editors can reduce the likelihood of biostatistical errors, significantly strengthening the rigor and credibility of clinical research articles. This leads to more accurate conclusions and improved patient outcomes (12,13).

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