المجلة الإلكترونية الشاملة متعددة التخصصات
العدد السابع والثلاثون شهر (٦) ٢٠٢١

Some Statistical Errors In Medical And Biological Sciences: Review

Saad J Almaliki

Saad8582@hotmil.com

Taif University, Saudi Arabia

Abstract

Statistical analysis is widely used in the medical field and it is relied upon in crucial decisions in adopting a vaccine or proving the effectiveness of a treatment or a treatment method. In this study, a number of studies were reviewed that reviewed the statistical work in research were published in the medical sciences and demonstrated the persistence of huge statistical errors in all stages of the research process and in all parts of the statistical process. This included scientific journals with high, medium and low Impact factor. The study reviewed the most common errors in this field, and discussed the most important reasons that led to the persistence or even rise of statistical errors. A number of basic solutions have been proposed to reduce these errors, such as strengthening the statistical aspect in the general curriculum and the undergraduate level in medical specialties, as well as coordinating the research process to bring together medical professionals and statisticians, that will have a significant impact in improving medical research and statistical performance. The scientific journals will have a big role in addressing errors by presenting the research to specialist arbitrators in statistics.

Keywords: medicine, statistical analysis.

المجلة الإلكترونية الشاملة متعددة التخصصات
العدد السابع والثلاثون شهر (٦) ٢٠٢١

بعض الأخطاء الإحصائية في العلوم الطبية و البيولوجية : مراجعة

د. سعد جمعان عبدالله المالكي،

ملخص (عربي)

يستخدم التحليل الإحصائي في الحقل الطبي على نطاق واسع ويعتمد منه قرارت مصيرية في اعتماد لقاح أو اثبات فعالية علاج أو طريقة علاج. في هذه الدراسة استعرضت عدد من الدراسات التي راجعت العمل الإحصائي في البحوث المنشورة في العلوم الطبية وأثبتت استمرار ارتكاب أخطاء إحصائية كبيرة في كافة مراحل العملية البحثية وفي جميع أجزاء العملية الإحصائية، وشمل ذلك المجلات العلمية ذات معاملات التأثير المرتفعة و المتوسطة و المنخفضة. واستعرضت الدراسة أكثر الأخطاء شيوعاً في هذا المجال، و تم مناقشة أهم الأسباب التي أدت إلى استمرار، بل ارتفاع، الأخطاء الإحصائية. تم اقترح عدد من الحلول الأساسية للحد من هذه الأخطاء مثل تعزيز الجانب الإحصائي في المناهج الدراسية العامة والمرحلة الجامعية في التخصصات الطبية كما أن تنسيق العملية البحثية لتجمع بين المتخصصين في الطب والإحصائيين سيكون لها أثر كبير في تحسين العمل البحثي الطبي ورفع الأداء الإحصائي فيه، وسيكون للمجلات العلمية الدور الكبير في معالجة الأخطاء بعرض البحث على محكمين مختصين في مجال الإحصاء.

الكلمات المفتاحية : الطب ، التحليل الإحصائي .

Introduction

Scientific research, whether in the natural sciences, social sciences, humanities and medical sciences, is hardly devoid of statistics in particular, even in religion sciences.

Statistics contribute to understanding the nature of the research problems, describing the current situation and explaining the phenomena predicting the future, comparing and helping to making the right decision. If the studies are appropriately designed and the statistical tools are applied, starting with community identification, sample selection, methods, and statistical tools properly, then there is no doubt that those researches will be very beneficial and will achieve the best and maximum outcomes in its field.

Statistics has many benefits in improving the results and quality of research significantly, as it helps to guide the research to the correct and optimal way to collecting data, support or exclude research hypotheses, as well as explain the discovery of the invisible part of the data, discover errors and predict the future. On the other hand, the statistical error in scientific research will have the exact opposite effect. Indeed, failure to discover the error, and this is what often happens, will exacerbate the problem because we will deal with the error as if it was a proven scientific fact. The weakness or the absence of the statistical aspect in research will undoubtedly, miss many important results and scientific facts. If statistical errors occurred in a medical research, the consequences and losses would be more severe and catastrophic. The nature of medical research makes it difficult, if not impossible, to correct statistical errors at the end of the research.

This article sheds light on the problem of “Errors in Medical Research” and lists some studies that have reviewed the statistical work in some preliminary studies to treat that or to helping reducing the amount of error.

Statistics in Medical Sciences

Research in the field of science, especially medicine and medical sciences, uses statistical analysis as an essential part of one of the research stages. Studies indicate that there is an increase in the use of statistics in medicine and medical and biological sciences in recent decades, Strasak el.et al (2007) and Narkevich and Vinogradov (2020). Statistics plays a pivotal and important role not only in medical scientific research, but also in care, health management, planning, improving the quality of medical services, development and decision-making.

Various statistical methods and patterns are being used in several published researches using various statistical tools in medical sciences, as it included statistics in both descriptive and inferential sides in all of its branches such as data presentation and summarization, data analysis, graphics, simple and multiple linear (and non-linear) regression, analysis of variance, hypothesis testing, factor analysis and design Experiments and others. Usually inferential statistics are used less in medical journals research with a low impact factor, and a large proportion of them are satisfied with descriptive statistics and some simple inferential aspects. On the other hand, the use of inferential statics increases in prestigious journals. In a comparison of the use of statistics in medical research in the New England Journal of Medicine and Nature Medicine, which are distinguished medical journals, Strasak el.et al (2007) reported that about 95% and 83%, respectively, of the published researches contained inferential statistic. In a review of the published medical research in medical journals in Pakistan, it was found that only about 41% used inferential analysis in the published research, Hanif, and Ajmal, T. (2011)

Common errors

Many studies that have reviewed the statistical work in this field indicate that the number of statistical errors in published research in the medical and biological sciences has increased greatly, as mentioned by Cooper et al (2002) and Gardenier and Resnik (2002) and indicated in a recent study by Narkevich and Vinogradov (2020) that errors are not limited to a certain stage of the statistical process, but included in all stages, whether the stage of data collection, specifying the study group, selecting the sample, all the way through the descriptive, analytical and inferential statistical aspects to decision-making and recommendations, Altman (2000).

Statistical errors in published research in medical sciences were distributed among all types of scientific journals, whether low or medium rated, and extended to international highly rated journals. This has very serious consequences, as in addition to wasting time, effort and money, these errors will undoubtedly result erroneous medical recommendations, decisions, and conclusions and thus unethical practices in relation to patients, see, Wiles and Bishop (2013) and Gardenier and Resnik

The main statistical stages where errors occur usually, happens in the stage of study design, the descriptive aspect, the analytical aspect, or the aspects related to decision-making, recommendations and forecasting. Some studies such as Strasak el.et al (2007) as well as Narkevichand Vinogradov (2020) discussed the most common statistical errors in medical research, and included errors related to sampling methods, data collection, presentation and summarization of data and appropriate statistical tools such as questionnaires design, data analysis and statistical tests and comparisons making. Errors in statistical tests are among the most common errors, in addition to using statistical methods that assume the naturalness of data for data that are not normally distributed. Errors include interpreting the results and recommendations making.

In a study of 164 scientific papers focused on the statistical aspect, and was published in the British Journal of Psychiatry, McGuigan (1995) indicated that about 40% of those research contained statistical errors. And in another study on the most common statistical errors, Wiles and Bishop (2013) estimated that about 40%, at the very least, of the biological and medical scientific papers that contained statistical analysis, in one of its parts, contain many wrong statistical methods, either Incorrect or inappropriate data collection, presentation or analysis.

Gore et al. (1977), reviewed research published in the British Medical Journal in the third month of 1976, and it was found that about 52% of this number fell in at least one statistical error. Other study of 141 papers published in the Journal of Infection and Immunity in 2002 concluded that more than 70 research papers made mistakes in the data analysis, presentation and summarization stages, Olsen CH (2003). The stage of displaying and summarizing the data is one of the initial and basic stages, which is a relatively simple statistical stage; consequently, higher levels of the statistical process will have a higher percentage of errors. Karadeniz (2019) reviewed 157 studies that were published in twenty radiology journals between 2016 and 2017, and the journals had different levels of impact factors, these studies were examined from statistical aspects including examining data summarization and statistical tests. The result of this study concluded that 147 papers, with a rate of more than 93%, contained statistical errors (at least one error), and the errors related to data summarization were more apparent than errors related to statistical tests. The performance of scientific journals with high impact factor was not significantly different from their medium and low impact factor counterparts. The Nature Neuroscience journal published a study in neuroscience in 2011 on statistical errors in research that was published in five of the best journals in neuroscience, indicated that more than 43% out of 167 papers used statistical tests correctly. That shows the errors in the statistical tests exceeded 53%, Nieuwenhuis et al (2011).

Some Reasons

This huge amount of statistical errors in medical research appeared in medical scientific journals, some of which are among the best international journals. Of course, these errors will increase in lower quality journals and in less advanced countries in science and medicine. These errors have many and overlapping reasons, some of which are related to the past and some of them related to the present, for example one of the main reasons is the weakness of statistical knowledge in the researchers in general, and researchers who are specialists in medical sciences, which is a major cause for the prevalence of statistical errors in medical research, and that might be due to a weakness in the statistical subjects at the undergraduate level in medicine and medical sciences, not to mention the weakness of the curriculum in schools in relation to statistics, in some countries.

Also one of the main contributing reasons to those errors is not to involve statisticians in an advanced stage of the research, and it is difficult to correct the statistical error in medical research, especially since it may occur in an initial stage such as selecting a sample, add to it is how difficult if was not impossible to repeat many experiments and the medical procedures that have been completed. If statisticians were involved, those errors could easily be avoided.

Also, arbitrators usually, arbitrate the medical research come from a medical background, and they may lack statistical knowledge, which makes the chance to detecting errors very slim. Usually, they review and judge the medical part only with some statistical guidelines but, they do not possess the statistical cognitive and the ability to spot errors.

The statistical references and learning resources, despite their availability, are not useful to medical professionals and do not help them enough to avoid errors, as many scientific references in statistical sciences and data analysis contain a large amount of statistically deep theoretical issues and contain many mathematical equations and formulas. Somewhat complex, which requires a specialist in mathematics and statistics to master it, which makes the opportunities to benefit from it very limited, as they do not have sufficient mathematical and statistical skill and knowledge to understand these resources.

The abundance in programs specialized in statistical analysis may exacerbate the statistical errors and become a negative factor, although many programs are easy to use by non-statistical specialists, where researchers from a medical background focus on one matter at the expense of several statistical measures and perform statistical tests with great accuracy and errors lie in the interpretation of the apparent results or other errors.

Suggested solutions

Addressing these problems during the statistical analysis of medical research requires many measures and precautions in the short, medium and long terms to gradually reduce those errors.

In the long term, the importance of the statistical aspect should be recognized and to be taught in the curriculum at a very early stage, and the development of statistical skills at all school levels.

In the medium term, treating those errors requires working on developing, improving and refining statistical skills at the undergraduate level in the Faculties of Medicine and Medical Sciences, taking into account the practical aspect of analysis without prejudice to the theoretical mathematical aspect. Developing the aspect of statistical analysis in different academic stages for doctors and students of medical sciences will limit the amount of error and makes it possible to avoid such errors, trying to do so after graduation, especially for medical doctors, may be a very difficult task.

By engaging statisticians at a very early stage when preparing medical research with medical specialists will help to reduce statistical errors significantly, in the short term, as it provides a good environment for the medicals to develop their statistical skills.

On the other hand, these errors can be reduced if the medical scientific journals play a greater role in reviewing and refining the statistical aspects and to review and arbitrate the statistical methods used in medical research closely, not to leave the evaluation and arbitration processes to be done by medical specialists only. (Gardner and other 1983)

Conclusions

The persistence of statistical errors in medical research until the present time leads to many negative results and wastes effort, time and money, especially it comes at a massive financial cost , also it has a very serious health consequences in some cases if this wrong statistical analysis results in a decision has something to do with the health of patients, treatment methods, or the development of a vaccine for a specific pandemic . There is no doubt that the reasons are interrelated and multiple, starting from the weakness of the statistic subject in the curriculum in the educational stages, up to the university curriculum in the Faculties of Medicine and Medical Sciences, and the absence of a statistician during the preparation of medical research will increase the possibility of errors and its recurrence. The efforts to raise mathematical and statistical skills in all academic stages and to involve statisticians in the initial stages of medical research, and to emphasize the scrutiny of medical research by statisticians during the phases of medical research arbitration will gradually reduce statistical errors and raise the quality of medical scientific research, taking into account the need for more organized collaborative joint scientific work.

References

1. Narkevich, A. N., & Vinogradov, K. A. (2020). THE MOST COMMON ERRORS IN MEDICAL RESEARCH. *Ekologiya cheloveka (Human Ecology)*, (7), 59-64.
2. Altman, D. G. (2000). Statistics in medical journals: some recent trends. *Statistics in medicine*, *19*(23), 3275-3289.
3. Cooper, R. J., Schriger, D. L., and Close, R. J. H. (2002), "Graphical Literacy: The Quality of Graphs in a Large-Circulation Journal," Annals of Emergency Medicine, 40, 317–322.
4. Gardenier, J. S., and Resnik, D. B. (2002), "The Misuse of Statistics: Concepts, Tools, and a Research Agenda," Accountability in Research, 9, 65–74.
5. Olsen CH (2003) Review of the use of statistics in infection and immunity. Infect Immun
6. Strasak, A. M., Zaman, Q., Pfeiffer, K. R., Gobel, G., & Ulmer, H. (2007). Statistical errors in medical research--a review of common pitfalls. *Swiss medical weekly*, *137*(3-4), 44-49.
7. Strasak, A. M., Zaman, Q., Marinell, G., Pfeiffer, K. P., & Ulmer, H. (2007). The use of statistics in medical research: A comparison of The New England Journal of Medicine and Nature Medicine. *The American Statistician*, *61*(1), 47-55.
8. Nieuwenhuis, S., Forstmann, B. U., & Wagenmakers, E. J. (2011). Erroneous analyses of interactions in neuroscience: a problem of significance. *Nature neuroscience*, *14*(9), 1105-1107.
9. Wiles, S., & Bishop, A. L. (2013). *Common mistakes in data presentation and statistical analysis: how can the BioStat Decision Tool help?* (No. e92v1). PeerJ PrePrints.
10. Karadeniz, P. G., Uzabacı, E., Kuyuk, S. A., Kesin, F. K., Can, F. E., Seçil, M., & Ercan, İ. (2019). Statistical errors in articles published in radiology journals. *Diagnostic and Interventional Radiology*, *25*(2), 102.
11. Gardner, M. J., Altman, D. G., Jones, D. R., & Machin, D. (1983). Is the statistical assessment of papers submitted to the" British

Medical Journal" effective?. *Br Med J (Clin Res Ed)*, *286*(6376), 1485-1488.

12. Hanif, A., & Ajmal, T. (2011). Statistical errors in medical journals (acritical appraisal). Annals of King Edward Medical University, 17(2), 178 178.