General Article

Common Errors, Illusions and Myths in Statistical Procedures

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Abstract

Statistical Procedure is one of the prime components of research which facilitates to draw firm inference from sample information. Although it has various advantages and strengths, its application sometimes may be misleading because of its assumptions, illusions and complexities. There are many sources of errors that arise from the application of statistical procedures. For example; errors may arise from planning, preparation of research instruments, basic assumptions, application of different research approaches, common errors also occur while reporting the research outcomes and drawing conclusions. Therefore, a grater care is to be paid while applying statistical procedures.

Key Words: Errors, Illusions, myths and statistical procedure

Introduction

The Word statistics have been derived from Latin word "Status" or the Italian word "Statista", meaning of these words is "Political State" or a Government. Several sources document that the history of statistics goes back to mid-eighteen century. In that time, statistics was mainly concerned with the systematic collection of demographic and economic data by the states. The main purpose of such collection was related to either human and material resources that might be taxed or put to military use. But in the early 19th century, the collection of information was intensified and the meaning of the statistics broadened to the collection, summary and analysis of data. In modern terms, "statistics" means collection, presentation, analysis and interpretation of all types data. Now a days, statistics has become one of the important disciplines without which no research can be thought (Walker, 1975).

Although the origins of statistical theory lie in the 18th century advances in probability, the modern field of statistics only emerged in the late 19th and early 20th century in three stages. The first wave, at the turn of the century, was led by the work of Francis Galton and Karl Pearson, who transformed statistics into a rigorous mathematical discipline used for analysis, not just in science, but in industry and politics as well. The second wave of the 1910s and 20s was initiated by William Gosset, and reached its culmination in the insights of Ronald Fisher. This involved the development of better design of experiment models, hypothesis testing and techniques for use with small data samples. The final wave, which mainly saw the refinement and expansion of earlier developments, emerged from the collaborative work between Egon Pearson and Jerzy Neyman in the 1930s (Walker, 1975). Today, statistical methods are applied in all fields that involve decision making, for making accurate inferences from a collected body of data and for making decisions in the face of uncertainty based on statistical methodology.

There are several statistical procedures that are equally applicable in all areas of research (natural sciences, social sciences, management sciences, health sciences, educational research and other behavioral sciences). Although some statistical computations are harder to understand by general readers, the development of computer software have facilitated to compute the different measures easily. Electronic computers have expedited more elaborate statistical computation even as they have facilitated the collection and aggregation of data. A single data analyst may have available a set of data-files with millions of records, each with dozens or hundreds of separate measurements (Anders, 1998 & de Moivre, 1738). It is obvious that statistics has becoming one of the prime tools for conducting research in any areas but a great attention is to be paid while using statistical techniques due to their limitations, complexities and illusions.

Sources of Errors

Majority of errors in statistics occur due to human activities (inability to plan appropriately). For example, preparation, measuring instruments, experiments, surveys, determination of sample size (power and significance

level), missing cases, non response, sampling from the right population etc may play a vital in the reliability and validity of statistical procedures.

In general, the researcher uses hypothesis testing, estimation and model building for decision making process. For the centuries, researcher have been using sample or samples to a larger incompletely examined population to draw the conclusion for the parameters (Berger and Berry, 1988). But less attention is paid in assumptions, nature of data and the applicability of such statistical procedures in the proposed study. There are numerous sources of error in applying statistical procedures such as;

A. Using the same set of data to formulate hypotheses and to test them
B. Selecting samples from wrong population or failing to specify the population about which conclusions are to be made in advance.
C. Measuring the wrong variables or failing to measure whatever the researcher expect to measure.
D. Not able to draw random and representative samples.
E. Using inappropriate and inefficient statistical models and
F. Failing to validate the proposed models.

Errors due to Fundamental Assumptions

Majority of the statistical procedures rely on two fundamental assumptions: that the observations are independent to each other and that they are identically distributed (iid) and the normality of population from which the sampling is done. If methods of collection fail to fulfill these assumptions, then analysis automatically fails to draw firm conclusions also.

Common Myths in Data Analysis

A. We think, complex analysis and big words impress people. However, most people appreciate practical and understandable analyses.
B. We assume that analysis comes at the end after all the data are collected. But We should think about analysis upfront so that we HAVE the data we WANT to analyze.
C. We believe that quantitative analysis is the most accurate type of data analysis. Some think numbers are more accurate than words but it is the quality of the analysis process that matters.
D. We say that data have their own meaning. However, data must be

interpreted. Numbers do not speak for themselves.

E. We consider that stating limitations to the analysis weakens the evaluation. But all analyses have weaknesses; it is more honest and responsible to acknowledge them.

F. We feel that computer analysis is always easier and better. However, data analysis depends upon the size of the data set and personal competencies. For small sets of information, hand tabulation may be more efficient.

G. A common and regrettable fallacy is that the maximum likelihood estimator has many desirable properties that it is unbiased and minimizes the mean-squared error. But this is true only for the maximum likelihood estimator of the mean of a normal distribution.

Common Errors in Reporting the Results

In report writing, the researcher should also pay a greater attention about what to report and how to report. Reportable elements include the experimental design and its objectives its analysis, sources of data and missing data.

A special care is also to be given while presenting the data in the form of frequency distribution (table) and diagram. Table must be enough to display information on title, margins and appropriate units. A less attention is paid during the construction of diagram and the diagram is generally constructed according to comfort, easiness and appearance. But the researcher should able to choose an appropriate diagram according to nature of data because the diagram and graph must be able to show the salient features and should reveal data properties and make large quantity of information coherent. Graphical illustrations should be simple and pleasing to the eye, but the presentation must remain scientific.

In choosing between tabular and graphical presentations, there are two issues to consider: the size (density) of the resulting graphic and the scale of the information. If the required number of rows for a tabular presentation would require more than one page, the graphical representation is preferred. Usually, if the amount of information is small, the table is preferred. If the scale of the information makes it difficult to discern otherwise significant differences, a graphical presentation is better (Good and Hardin, 2003).

One of the worst errors in statistics—one encouraged, if not insisted upon by the editors of journals in the biological and social sciences—is the use of the notation "mean ± standard error" to report the results of a set of observations. This expression is only applicable (reliable) when the sample comes from normal population. However, this expression may be misleading when the sample comes from non normal population.

Another important error that occurs in reporting the results of *p* values. Before interpreting and commenting on *p* values, it's well to remember that in contrast to the significance level, the *p* value is a random variable that varies from sample to sample. There may be highly significant differences between two populations and yet the samples taken from those populations and the resulting *p* value may not reveal that difference. Consequently, it is not appropriate for us to compare the *p* values from two distinct experiments, or from tests on two variables measured in the same experiment, and declare that one is more significant than the other.
If P value is misleading, then confidence interval can be used for interpreting the results.

A common error is to misinterpret the confidence interval as a statement about the unknown parameter. It is not true that the probability that a parameter is included in a 95% confidence interval is 95%. What is true is that if we derive a large number of 95% confidence intervals, we can expect the true value of the parameter to be included in the computed intervals 95% of the time (Duggan and Dean 1968; Gardner and Altman, 1996).

Confidence intervals can be used both to evaluate and to report on the precision of estimates and the significance of hypothesis tests. The probability the interval covers the true value of the parameter of interest and the method used to derive the interval must also be reported (Feinstein,1998).

Errors also occur due to the allocation of treatments. Allocation details (randomization, advance preparation of the allocation sequence, allocation concealment, fixed versus varying allocation proportions, restricted randomization) should be fully explained in report.

Missing data has also significant impact on quality of research outcomes. The researcher must mention such exceptions in detail. The missing data

includes; participant do not participate in interview, ineligibles, withdrawals and crossovers etc.

The next serious errors that arise from bias at the different stage of the study. Bias arises from sponsors, researcher, co-researchers, enumerators and respondents. With careful and prolonged planning, we may reduce or eliminate many potential sources of bias, but seldom we will be able to eliminate all of them. Most biases occur during data collection, often as a result of taking observations from an unrepresentative subset of the population rather than from the population as a whole (Badrick and Flatman, 1999).

Many researcher feel proud of using regression models in their study but less attention is paid on several dimensions model building such as; assumptions, adequacy of data, data set that covers entire range of interest, coefficient of determination, overall fit of model, significance of parameter and applicability of the model. There are at least five serious complications while fitting model:

Limited scope—the model we develop may be applicable for only a portion of the range of each variable.

Ambiguous form of the relationship—a variable may give rise to a statistically significant linear regression without the underlying relationship being a straight line.

Confounding—undefined confounding variables may create the illusion of a relationship or may mask an existing one.

Assumptions—the assumptions underlying the statistical procedures we use may not be satisfied.

Inadequacy—goodness of fit is not the same as prediction.

Regression models can be less successful for biological and social science applications. Before undertaking a univariate regression, researcher should have a fairly clear idea of the mechanistic nature of the relationship Look for deviations from the model particularly at the extremes of the variable range. A plot of the residuals can be helpful in this regard.

Illusions in Approaches

Since a long period of time, there is a contest between qualitative and quantitative research. One of the hot methodological debates in organizational and social sciences involves the relative merit of qualitative versus quantitative research. Supporters of qualitative research make strong claims about the strengths of their approach, including greater ecological validity, richer and more descriptive accounts of real-world events, and greater ability to uncover processes and mechanisms in natural settings (Maxwell, 2004). However, the quantitative research camp lament the advantages of their approach, discussing strengths such as precision of measurement, experimental control, and generalizability. Some of the beliefs associated with qualitative research are: qualitative research does not utilize the scientific methods; qualitative research lacks methodological rigor (qualitative research lacks internal validity; qualitative research lacks construct validity), qualitative research contributes little to the advancement of knowledge (Lance and Vandenberg, 2009).

Although different in focus, emphasis, and form, both approaches are striving toward a common objective—the advancement of scientific knowledge. Qualitative inquiry is an essential step in the process of initial discovery, just as quantitative research is necessary to confirm or disconfirm specific relationships among variables nested within a broader system.

Conclusion

The analyses clearly reveal that no statistical procedure becomes cent percent correct due to its assumption, limitations and coverage. We should pay a greater attention to minimize various errors from the very beginning of study (starting from planning to report writing and drawing the conclusion). Every scholar should be able to understand the basic principle underlying to each statistical procedure before use.

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Main texts should be organized under the following headings:

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Acknowledgment: Should be short and specific providing information about various supports (eg funding, supervision, field assistance) received for research.

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